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ENGINEERING NEWS.

ENGINEERING TRAINING—ITS STRONG AND WEAK POINTS.

As we stated two weeks ago, we felt moved on reading the letter, an extract from which we printed in the ENGINEERING NEWS of Dec. 23, to add some words of encouragement, of advice and of caution, to our young brethren. We offer them therefore to-day, hoping that they will be received in the kind spirit in which they are intended.

It is comparatively but a few years since special schools were established in this country for the training of engineers. Before that time the desired theoretical knowledge beyond some mathematical drill, was usually acquired under the guidance and in the office of a working engineer, a busy man who had little time to oversee the study of his pupils and to lead their efforts in the right direction. As he naturally could not give the best of his energies to systematizing his instruction and improving his methods, we can easily see how better results can be accomplished with a less expenditure of time, when pupils are placed with men who make it their whole business to guide them aright. In this way the young engineer is rapidly placed in possession of the theory of his profession, all the facts are arranged so as to come in natural sequence, and the latest discoveries, improvements and results of experimental research are laid before him.

Again, if we go back to the time of the youth of engineers who are still active in their vocation, we shall find that many problems have been successfully solved since then. All investigators are striving to extend the bounds of human knowledge, and the progress in all branches of science, during the last fifty years has been simply wonderful. The time has probably passed when uneducated men, with only sound common sense and indomitable pluck, can make that mark in the engineering profession which some of the late famous engineers of England have done. Railroads were then in their infancy with all those classes of work which they called into existence. The modern theory of structures has grown up altogether since that time. Thermodynamics, the useful applications of electricity, and many powerful inventions have been developed in late years. The task is formidable to the man who should undertake, unaided, to inform himself thoroughly of the present state of knowledge, and to go forward, shoulder to shoulder, with the workers in science.

Does the young engineer ever consider how fortunate it is that the assistance of the nation or the state, or that private endowment places within his reach, the services of instructors, the collections of models and illustrations of all kinds, books on science and technology in abundance, very little, if any, of which aids he could command with the fees which he is called upon to pay. In place of being obliged to search through and read authors in great numbers for information which he thinks may be of use to him, the authorities are collated, references are made, and he is given a course of instruction which is deemed to be most judicious for his chosen vocation, at a time too when his ignorance of all which that vocation may demand of him, makes him unable to select his course of study wisely for himself.

He therefore goes forth, well equipped with a knowledge of theory, and acquainted to a good degree with what has been already accomplished, so that he need not spend his time in striving after impossibilities, and can reap the advantage of other mens' progress. How often has some man of limited information found, after months of work and investigation, that the problem which he has been striving to solve, has been worked out before by some one else, with perhaps a more satisfactory result! The graduate then, of our best technical schools, instead of climbing painfully, step by step, the ladder of personal experiment and investigation, to find out each truth for himself, is, if the metaphor may be continued, taken up by an elevator whose cost is defrayed by public or private beneficence, and is started out in life from the higher vantage ground of others' knowledge. Let us hope that, through inaction on the way, his legs may not have become too weak, nor from his sudden elevation his head become too giddy to bear and guide him successfully when he is thrown on his own resources.

Herein lies one weak point of our scientific training, a too rapid accumulation of information. A mass of dry facts and details will not stay in a pupils' mind; unless he has an opportunity to verify statements experimentally, to see, so far as is possible, the classes of engineering work to which his theoretical study refers, and to go through such operations and make such designs as are practicable, and as accord with the usual field and office work of an engineer, he might as well not have been crammed with a mass of information which he has not had time to digest. Then the young graduate lacks experience. What some consider the *practical man*, is one who is all experience and no theory; such a man we consider about as bad at the present day, when any progress is desired. No steady patterning after previous examples, or following "rule of thumb," will enable us to advance. A happy union of theory and practice is what is found in the best men of the profession.

Another source of weakness with some young men is over-confidence. Too great attention, perhaps may have been paid in their scientific training to the pure mathematical calculations, and too little weight given to elaborating details. Computations and investigations carried to great length, tend sometimes to make us forget the premises and assumptions upon which they are founded, and it is proper then to review the work, examine the base upon which we have built, and see whether it is worth while to cipher with seven-place logarithms, and carry out results to several places of decimals, when the whole calculation may depend upon a breaking strength, a modulus of elasticity, an angle of repose, or some other constant of the material with which we deal, which is only an average value and stated in round numbers. Why use a large factor of safety, and then determine the cross-section of a piece to a small fraction of an inch? Still, if we do not use the mathematically correct results, we are not advocating guessing. We would strike a happy mean between pure theorizing and arbitrary rules.

The habits of caution and circumspection which old engineers possess the rising generation are prone to term old fogyism. But such habits they will, if they ever do much work, and profit by their experience, acquire themselves. We are all liable to make mistakes. If they are of any importance, if they entail any expense, we are not likely to forget them, and to repeat them. We are better taught by such m shaps than by all our successes, but such teaching is very expensive. The engineer of good judgment soon learns to view with exceeding care, results and proportions which a common sense view of the case would hardly lead him to expect, and he also appreciates the fact that the weakest detail in a structure determines its power of endurance.

A masonry culvert may be substantially built, but a weak spot of limited extent in the foundation may be searched out by the water at a time of flood and be the cause of the failure of the structure. An apparently well-built bridge, may, from the weakness of one or two floor timbers, of poor stock or hidden defect, not seen on casual inspection, be completely wrecked, on the breaking through of a train. We have not endeavored to present the need of caution in an engineer on the ground that he is intrusted with the carrying out of works on whose faithful construction depend many human lives, for this branch of the subject is so evident as to appeal to all without words of ours.

The young engineer then starts out under favorable auspices. He has a good scientific training, zeal, energy, and perseverance; he must, to do well, be ballasted with prudence and caution in applying his talents to the work of bending the powers of Nature to the service of man. In that case we can fitly close with the words of the letter which we recently quoted, and which suggested these remarks,—"With such advantages, if young America does not soon supercede old America, it will be, not from the want of power, but from lack of its proper use."

THE ASHTABULA DISASTER.

The month of December 1876 will be remembered as replete with disasters almost unparalleled in this country, resulting in terrible loss of life. First, the Brooklyn holocaust,—then the wreck of the Circassian on the shore of Long Island resulting in the death of nearly thirty persons, and last the fatal plunge of the Pacific Express through the Ashtabula bridge on Friday night Dec. 29th.

The incidents of this most recent accident are already familiar to our readers through the daily press and it is not our province to repeat them here. The bare facts are sad enough without any reportorial coloring. As to the cause of the accident all is as yet surmise, and but little satisfaction can be derived from the meagre evidence at hand, and from the conflicting and too often pernicious accounts of the daily papers which deliberately charge,—on the wildest rumors and vagaries,—railway officials and all connected with the accident with the most derelict attention to duty and culpable carelessness both before and after the catastrophe. These sentiments even creep into the editorial columns of our papers and we notice in one of our morning dailies a wholesale condemnation of the entire class of iron bridges. The writer of the article in question should know better. Sufficient to say that there was a cause, and that probably it will be found out in due time and satisfactorily explain the failure of the bridge, although that will not recoup the loss of life.

We write this week not because we have any satisfactory explanation to offer but in order to lay the data for an opinion, so far as known, before our readers and dispel some of the illusions which have possessed the public mind.

Last Friday, day and night, Dec. 29th, was noted along the Lake Shore road and farther east for its unusual snow fall, followed by a severe, cutting wind, which piled it up in drifts making railway travel extremely difficult and vexatious. Trains were delayed on nearly all the eastern roads and on some were entirely blocked. The Pacific Express on the M. S. & L. S. R. R., consisting of two engines, four baggage and express cars two ordinary coaches, one smoking car, one palace car and three sleepers in the order named, left Erie at 5:01 P. M., 1 h. and 8 m. late and was due in Ashtabula at 5:15 P. M. After working through the snow it arrived at Ashtabula bridge, a few hundred feet from the depot, at about 7:30 P. M., and with a velocity of 10 to 12 miles per hour

When the head of the train had nearly reached the farther end of the bridge this structure gave away, from some cause not known, and the entire train, excepting the forward engine which crossed in safety, was precipitated into the ravin · of Ashtabula Creek, falling about 75 feet, and in a short time thereafter being entirely consumed by fire. The number of passengers on board has been variously estimated at from 130 to 300. According to the testimony of the conductor there were 160 when the train left Buffalo, and at the time of the accident 138, exclusive of those who got on west of Buffalo, and those who held return tickets. The account so far as made out by the railway officials from collecting the tickets and comparing them with conductors' accounts, etc., gives the list as follows:—

	Whole No.	*Killed.*	*Saved.*
Passengers	137	*80	57
Train men	12	*7	5
Employes	4	2	2
Expressmen	3	1	2
Children	2	2	0
Total	158	92	66

*Two passengers and one train man, who died after being rescued, are included.

The bridge was a double track, deck or over grade structure, a single span of 157 ft., Howe truss type, built in iron, having two truss systems. It was built about eleven years ago at the Cleveland shops of the Lake Shore Company before its consolidation with the Michigan Southern, and during the presidency of Amasa Stone, and was designed by John Towlinson now Director of Canadian lighthouses. We believe that it was considered entirely safe by Mr. Collins now Chief Engineer of L. S. & M. S., a man who has the reputation of being one of the most careful railway engineers in this country and the most exacting in all the requirements for permanent structures.

Mr. Chas. Paine, Gen. Supt. of L. S. & M. S., and Chief Eng. of the Michigan Southern previous to the consolidation with the Lake Shore, a man everywhere regarded as of the utmost probity and ability has been on the ground ever since the accident and from his report, when made, and the result of the coroner's inquest we shall be able to frame an opinion, if not entirely satisfactory, at least above criticism.

Not enough is known as yet to form even a tentative opinion. So far as the bare evidence before the coroner's jury is concerned, it appears that the forward locomotive was, as variously stated, from two car lengths to 45 or 50 feet from the farther end of the bridge, and and that the engineer of the forward locomotive feeling either a sinking of the bridge or a dragging of the trucks behind as if off the track, suddenly pulled the throttle wide open, his engine in the meantime appearing to go up grade; the coupling connecting his tender with the following engine was broken, presumably at the time the throttle was pulled wide open, and his engine escaped to the farther abutment, running some 150 feet before coming to a stand still, the four wheels of the rear truck of the tender being derailed as it struck the abutment apparently by the swinging of the bridge to one side He says he undoubtedly felt the bridge sink apparently in the middle. The second engine was pulled forward and struck the abutment with a great crash. Other evidence seemed to support his general statement. One passenger who escaped from the smoking car said he felt that the trucks of that car were off the track, but this is of no value for the reason that the smoking car was not upon the bridge at its initial fall.

The train was upon the left hand track and in the wreck the cars appeared to be thrown some 30 feet to the left of the center line of the bridge. As to the manner in which the bridge was decked, if decked at all, whether or not the cross-ties ran through and through from one track to the other, their dimensions, distance apart, whether or not they were so fastened apart by blocks or otherwise as to prevent them from being winrowed by a broken or derailed truck, the character of the floor-beams and the upper sway bracing, guard rails,—all necessary to a correct judgment of the immediate cause of the accident, we have no information.

The fact that the bridge must have been designed for a train of locomotives occupying each track at the same time, that it was tested by a train of six locomotives soon after its erection, that heavier trains must have crossed the bridge within a few hours, that probably in the great number of trains which are constantly crossing the bridge in both directions, two must have been upon it at a time quite recent,—all combine to preclude the idea of its falling from any intrinsic weakness of the structure itself, in its various parts.

The idea of its being weakened by a low temperature or from crystallization or disintegration of the structure of the iron from repeated strains does not merit serious attention at the hands of engineers. So far as any experiments that have been made give any grounds for a conclusion in regard to the effect of low temperature on iron, it seems to increase its resistance somewhat for a static strain and diminish it for a blow; metals rendered cold-short by the presence of phosphorous or other elements seem to be weakened by a low temperature. As regards weakening from repeated strains the evidence is not conclusive, experiments indicating that it is not weakened at all if the strains are within the elastic limits. The toughest iron broken by a blow gives a crystalline fracture, and much of the evidence for crystallization [which can only take place near the melting point] is based on this peculiarity. A year ago the Illinois Central railroad engineers took several bars from bridges which had been erected 13 years, and when tested they appeared as strong as when first put into the structures.

If no farther evidence were forthcoming our theory of the disaster would be:—Some of the wheels or trucks of the first tender, the second engine or tender or the first car became derailed in the snow east of the bridge, and on striking the cross-ties of the bridge with a succession of blows or gathering them up in a pile, plunged through breaking floor-beams and cross-bracing; the farther truss would be pulled in and the whole structure would cripple, meantime the top swinging bodily to the left the bridge overturning upon its seat. If the train became derailed in any manner on the bridge the probability is that it would go down however strong. This explanation seems consistent with the evidence so far as given, but we only offer it provisionally in the absence of facts necessary to a sound conclusion. The above theory seems to accord with the impressions of the engineers as expressed at the informal discussion at the Engineers' Club on Tuesday, and with that of various bridge and railway engineers with whom we have talked since, although all prefer to withold their judgment until farther evidence is shown.

This accident is quite similar to one which occurred on the Union Pacific on the Plains, the week preceding Christmas. The through passenger train bound east went through a trestle sixteen feet high. The engine we believe crossed in safety. Four cars went through all of which caught fire and burned; but fortunately beyond some severe bruises, every one but two or three escaped with their lives. Afterwards it was found that an axle of the forward car had broken a quarter of a mile or more back, the marks of the derailed truck being plainly discernable upon the ties. On striking the trestle the ties were winrowed before the broken truck until the strain was too great for the coupling connecting the car with the tender, which breaking, the rails meantime being unsupported, the whole train fell through and was wrecked.

Several other accidents in regard to bridges are in our mind which are peculiarly instructive at the present writing, but we shall defer them for a more opportune time.

THE NICARAGUA CANAL.

REPORT OF THE COMMISSION.

Gen. Humphreys, chief of engineers, Superintendent Patterson, of the coast survey, and Commodore Ammen, chief of the bureau of navigation, who were appointed a commission by the president to examine and report upon the surveys and projects submitted for the inter-oceanic canal across the Isthmus of Darien, completed their labors on the 26th ult, and sent the following report to President Grant:

1. That the route known as the Nicaragua route, beginning on the Atlantic side at or near Greytown, running by canal to San Juan river, following it by slack-water navigation to Lake Nicaragua, across the lake to Rio del Medio, and thence by canal to Rio del Brito on the Pacific coast, possesses both for construction and maintenance of canal greater advantages and offers fewer difficulties from engineering, commercial, and economical points of view, than any of the other routes shown to be practicable by the surveys, sufficiently in detail to enable a judgment to be made of their relative merits.

2. The summit level of this route Lake Nicaragua, is designed to be kept 100 feet above the level of the sea. This height is to be overcome on the Atlantic side by four dams in the San Juan river and 10 lift-locks, and on the Pacific slope by 10 lift-locks. The total distance from the Greytown end to that at Brito is 181 miles. Of this distance the Atlantic slope division from Greytown to San Carl s at Lake Nicaragua comprises 108 miles, of which 63 are by slack-water navigation and 45 by canal. The summit level division comprises 56 miles by Lake Nicaragua from San Carlos, at the head of the San Juan. to Rio del Medio. The Pacific slope division comprises 16 miles by canal from the mouth of the Rio del Medio to the mouth of the Rio del Brito. The dimensions of the locks proposed are 400 by 70 feet with 26 feet of water. Artificial harbors must be constructed at Brito and near Greytown, and although that at Greytown presents unusual features requ ring careful study and skillful treatment, there is no question of its practicability.

3. That the cost of the construction of this canal and harbor with all necessary adjuncts will be at least $100,000,000, and that the cost by any other route will greatly exceed the cost by this route.

4. That all preliminary arrangements having been made, the time required for actual construction should not exceed 10 years.

5. That an inter-oceanic canal across this continent should be under protection of all the nations interested, and that they should guarantee not only the neutrality of the canal and its works, but also of the continuous strip of territory on each side of not less than 50 miles in breadth, and of ocean approaches of not less than 100 nautical miles in any direction along the coast and out seaward from each end.

The President has communicated upon the subject with the leading maritime nations of Europe and has received favorable responses from a number of them. As soon as all shall have been heard from he will submit the whole matter, including the reports and corre spondence to congress, by special message. The indications are thought to be favorable for an early commencement of work upon the proposed canal.

We learn later that a new treaty has been consummated between the U.S. Government and that of Nicaragua in regard to the ship canal which will probably be transmitted to and confirmed by the Senate ere this reaches our readers. It provides for the construction of a canal from the Atlantic Coast at or near Greytown to the San Juan river, following it by slackwater to Lake Nicaragua, across the lake to Rio del Medio, thence by canal to Rio del Brito on the Pacific coast. The length of canal requiring excavation is 61 miles and the total estimated cost is $50,000,000.

The Nicaraguan government concedes neutrality rights; i. e., the neutrality of a specified width of territory on either side of the route, a certain length of seacoast necessary for harbors and the neutrality of the canal, extending 100 miles to sea. The ports of Greytown and Brito are declared free. In the event of war between Nicaragua and any government interested in the construction of the canal, all other governments are to be exempt from capture, blockade or other embarrassment so far as the canal is concerned.

The United States in conjunction with other powers, when the canal is completed, are to guarantee full protection from seizure or confiscation and also the neutrality of the work, so that the canal shall be forever open and free, and all capital invested secure. These guarantees are however to be withdrawn in the event, if the management is contrary to the treaty stipulations. The property of parties engaged in the construction of the canal is to be protected by the local government and the construction of the work is to be urged with all the influence of the United States and other interested powers.

The leading maritime powers of the globe are to be invited to participate and share in the construction of the work, and to enter into treaty stipulations to that effect. The canal is to be open to citizens of all nations participating in its construction on equal terms. The construction of the canal is to commence at the earliest practicable moment. Foreign governments have been notified of the intended action of our government.

In the absence of the detailed report of the Commission which recommended the Nicaragua route, it is impossible to review intelligently the grounds of its selection. The high character of the men on it, however, entitles it to all respect. Our own views as previously expressed inclined us to favor a farther examination of

the Panama route, at or near the site of the Panama railway, which is much shorter, has equally good harbors and as low a summit level, and, we believe can be constructed with equal cheapness. This route may have been precluded from consideration by treaty at the time of the railway's construction, which treaty, we believe, was framed with direct reference to the contingency of a canal. In the mean time the Columbian government has been now for a year or more endeavoring to attract attention to the route by Cacarica Pass and the Rio Tuyra, certainly one of the most impracticable of the many yet examined. Members of the French Geographical Society have also been advocating this route and endeavoring to organize an international commission to examine, survey and investigate all the routes across the Isthmus, apparently ignoring all the excellent surveys and reports made by American engineers, and expeditions sent out for that purpose, or, exhibiting a most profound ignorance in regard thereto. Hence, from that government at least, we shall expect a considerable exhibition of brake-power, until the construction of the canal is thoroughly assured and under way, and then an astonishing alacrity to join in the enterprise. Other governments, we have reason to believe, will join heartily in its construction.

As regards the Nicaragua route so far as this government is concerned many things may be said in its favor, and may have had weight in making up the decision of the board. The same considerations would apply with greater force to the Tehuantepec route, and were equally practicable in an engineering point of view. From the Atlantic ports to the Pacific ports of the U. S. and the ports on the west coast of Mexico, it is nearly a thousand miles shorter than the Panama route and considerably more than a thousand miles shorter than the route via the Tuyra river or the upper Atrato; and the distance to ports on the west coast of S. America is but slightly increased to American shipping. Considering the magnitude of the coasting trade that must necessarily spring up between the Atlantic and Pacific states, this is a consideration of no small force. The distance from Pacific state ports to foreign ports, to which their grain is largely carried, would not differ materially by any of the routes. Hitherto the grain fleets have left San Francisco for Liverpool via Cape Horn, landing their freight in the latter city at a cost but a very few cents per bushel in excess of the cost from Chicago to Liverpool during the prevalence of the late low summer rates. With the completion of this canal San Francisco can lay her grain in Liverpool or any other foreign port as cheap if not cheaper than can Chicago. So as a result of the canal the Pacific states will be able to compete with the valley or interior states in the foreign market, the Atlantic states will establish steamship lines to western S. America, Australia, New Zealand and China, and it will also be the shortest route from Great Britian and aujoining nations to the same countries. The Nicaragua Canal will be a greater national evangelizer than the Suez Canal can hope to be under the narrow sectional policy of Britain.

NEXT week we will commence the publication of a series of articles on "Arches; Considered Graphically," by Prof. Chas. E. Greene, which will be a continuation of the series on Bridge and Roof Trusses already published by the same author.

WE notice that the Mississippi Central and the New Orleans, Jackson & Great Northern Railways, 455 miles, have passed into the control of Illinois Central and been consolidated therewith, making a continuous line of 910 miles from Chicago to New Orleans. Mr. J. G. Clarke, General Manager of the Illinois Central, is made second vice-president, and specially charged with the care of the New Orleans line with probable headquarters at New Orleans.

DURING the past year we did not carry any back numbers of ENGINEERING NEWS for future sale. Neither will we do so this season, and as valuable papers both original and selected will hereafter be published in our columns more frequently than in the past, so it will be apparent that to secure a complete set an immediate subscription will be advisable. At the same time we wish it understood that the pages of "Sanitary Engineering" are stereotyped and may be had at any time during the year, although the price of the bound volume when completed will be more than our regular subscription rates. After the completion of "Sanitary Engineering" the sheets comprising it can only be had at an extra price.

CORRESPONDENCE.

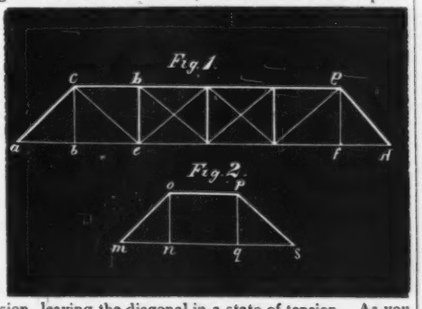
BRIDGE DESIGNING.

Editor ENGINEERING NEWS:

In your paper of December 16th I find an article on "Bridge Designing," which arrives at conclusions which appear to me erroneous. A truss is described as "of the Pratt type, 72 ft. span, 9 ft. high, 6 panels, the top chord running but four panels, so that the sloping members at the ends are struts, and the first verticals are suspending rods. Load on bottom chord."

The diagram, Fig. 1, represents such a truss.

The query is put: "If a live load of 7,200 lbs. hangs by the first vertical, in what manner will one-sixth of it pass to the further abutment?" If I correctly understand your position, it is, that the strain from the load at the bottom of *b c*, Fig. 1, being a vertical one, cannot strain a horizontal member like the top chord *c g*, and (quoting from your article) "the only course for that strain in its movement toward the further abutment, is down the diagonal in the second panel (*c e*). For this load alone the strain on the diagonal would be compression, and, as this member is intended to be a tie, it would carry but very little thrust." Then you state that the steady load on other parts of the truss, produces a tensile strain on the diagonal *c e*, which, being the greater of the two strains, overbalances the compression, leaving the diagonal in a state of tension. As you say nothing of the further movement of this compressive strain, it seems you consider it annihilated by the greater tensile strain, without ever reaching the further abutment toward which it started.



Now, in Fig. 2, a load which is carried by the vertical *n o*, must certainly produce a strain in the horizontal straining beam *o p*. Two-thirds of the load on *n o* will pass down *o m* to the nearer abutment, while one-third will pass along *o p* and *p s*, to the farther abutment, and the truss will not fail except by the rising of the point *p*, which will be prevented by placing an equal load on *p q*, or, by inserting counters. I cannot conceive how the insertion of a tie in the diagonal *o q* could in any manner change the course followed by the strain in passing from *n o* to the abutment at *s*. Now in Fig. 1 suppose all the web members, except *b c* and *f g*, to be removed, the truss would then be in a precisely similar condition to Fig. 2. It seems to me very plain that one-sixth of any load supported by the tie *b c*, must necessarily pass along the whole length of the top chord, and down the strut *g h* to the further abutment, while five-sixths of it passes down the strut *a c* to the nearer abutment, thus following the same course as a load carried by *n o* in Fig. 2, or by *b c* with all web members removed except *b c* and *f g*.

If my views are wrong I shall be very glad to be corrected by some of your correspondents, or by yourself.

A. H. B.

LITTLE ROCK, ARK., *Dec.* 26, 1876.

We are rather surprised, and not a little amused that anyone should suppose we considered the compressive stress, which a weight at *b* would cause in the diagonal *c e*, to be so thoroughly annihilated by the tension in that same member as to have no effect elsewhere in the truss. As the designers of strain sheets previously referred to seemed to insist on carrying it over the top chord, we thought that, if we once got it successfully upon the tie *c e*, there would be no need of tracing its progress to the abutment at *h*, for which it was bound. Besides, as, in each of the middle panels, we had a choice of two diagonals, it would depend on the distribution of the rest of the load, steady or rolling, which diagonal would be in action. As the original problem did not specify this point, we did not trace the stress beyond *c e*.

As to our correspondent's Fig. 2,—If "the insertion of a tie in the diagonal *o q*" will not "change the course followed by the strain in passing from *n o* to the abutment at *s*," why put in *o q*, which, by the way, would then be a strut and not a tie?" It seems to us that our subscriber proves too much. We cannot see, if we adopt his reasoning, why, by a slight modification of his design, he might not leave out all the counters (of which his sketch had four), and, possibly, do away with bracing altogether. Then suppose the truss had vertical end posts:—the one-sixth of the weight at *b* would of course then go by the bottom chord, for we should have no strut *a c* to compress the top chord, and we should find that an alteration in a member at one or both ends of the truss had changed the amount of stress in portions say at mid-span, something which cannot be true.

We would suggest that A. D. B. study over Fig. 2 a little more, considering the action of a partial and unsymmetrical load.—[ED.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 71st regular meeting of the Club was held at the Sherman House Club Rooms on the 2d of January, 1877, beginning at 4 P. M.

The President, Mr. E. S. Chesbrough, not being present, Mr. Blunt was called to the chair.

The minutes of the December meeting were read and approved.

The Secretary reported a donation from the Union Iron Company, of Buffalo, N. Y., of the latest edition of the "Book of Shapes" issued by that Company.

Ballots were cast for the following gentlemen proposed as members at the last meeting: J. W. Weston, W. F. Goodhue and C. G Artingstall, resulting in their election.

Mr. Roney stated that Mr. Henry Gannett was now engaged by the Department of the Interior in extending the work begun by Mr. James T. Gardner, of obtaining data to determine the elevation above the sea of as many points as possible in the United States, and that Mr. Gannett would be obliged to members if they would forward to him at Washington, D. C., any memoranda that would further his work.

(Mr. Chesbrough, having arrived, took the chair.)

Mr. Morehouse read the paper for the evening,—"Memoranda Concerning the Blasting of Ice in the Winter of 1875," also a letter from Col. F. A. Farquhar upon the same subject.

After discussion of the topic an informal discussion was had of the recent bridge disaster at Ashtabula. No member present having any personal knowledge of the bridge or of the accident, no opinion was expressed as to the cause of the failure of the bridge.

The meeting adjourned.

L. P. MOREHOUSE, *Sec.*

PUBLICATIONS RECEIVED.

From the Boston Society of Civil Engineers:

Report of Standing Committee on the Metric System of Weights and Measures. Boston: December, 1876.

Journal of the American Society of Civil Engineers, for November, 1876., with an appendix containing Discussions on Technical Education at the Washington Meeting of the American Institute of Mining Engineers, February 22d and 23d, 1876, and at a Joint Meeting of the American Society of Civil Engineers and the American Institute of Mining Engineers, at Philadelphia on June 19th and 20th, 1876. New York: 1876.

From the Institute of Civil Engineers:

"*On the Permanent Way of Railways.*" By R. Price Williams, M. Inst. C. E.

"*The Evaporative Performance of Steam Boilers.*" By D. Kinnear Clarke, M. Inst. C. E.

"*The Japan Lights.*" By Richard Henry Brunton, M, Inst. C. E.

Report of the Board of State Engineers to General Assembly of Louisiana for the year 1875. New Orleans: 1876.

Report of the Commission of Persons to the same. Session of 1876.

Report of the Levee Commission of Engineers to Governor of Louisiana. Session of 1876.

COAL GAS.*

BY WM. D. MARKS.

Distillation,—It is of the utmost importance to the gas manager to obtain from a given quantity of coal, the largest quantity possible of hydrocarbons which are gaseous at the ordinary pressure and temperature of the atmosphere.

To know how to obtain such result it will be necessary to discuss separately the constituents, so far as known, of coal gas and their behavior under the various circumstances in which they are placed during the process of manufacture.

Crude coal gas, as it comes from the retort contains about 14 known gases carrying with them in the form of vapor an unknown number of hydrocarbons which are condensed as tar and oil at the ordinary temperature of the atmosphere.

The gases may be divided into three classes.

1st. *Diluents.*

(H.) Hydrogen.

(C. O.) Carbonic Oxide.

($C. H_4$.) Carburetted Hydrogen.

The last named gas has for a long time been classed among illuminants, but experiments go to show that its illuminating power is *practically* nothing.

2d. *Illuminants.*

($C_2 H_4$) Olefiant gas. Also known as Ethyline.

($C_2 H_2$) Acetyline.

($C_3 H_6$) Propyline.

($C_4 H_8$) Butyline.

There exists besides, a very large number of gaseous hydrocarbons whose composition and properties are not yet known.

3d. *Impurities.* By impurities are meant all such gases or vapors as are, or ought to be, removed before the gas is delivered to the consumer.

They are as follows:

($S H_2$) Sulpuretted Hydrogen.

($C O_2$) Carbonic Acid.

($S_2 C$) Bisulphide of Carbon and perhaps some other organic sulphur compounds.

($N H_3$) Ammonia.

(C N) Cyanogen.

[S (C N)] Sulphocyanogen.

(O) Oxygen.

(N) Nitrogen.

Tar or liquid hydrocarbons which have been vaporized and thus carried along with the gas.

Diluents. Hydrogen is formed during the distillation of coal in very variable quantities, by the decomposition of water mechanically contained in coal, which is converted into steam and decomposed into Hydrogen; Carbonic Acid gas is formed by the red hot coke with which it comes in contact in the retort, and the same result is obtained when coal tar and steam meet in a red hot vessel.

Water absorbs 1.56 per centum of its own volume of this gas; it is not affected in any way by lime, and it burns with an intense heat giving very little light.

One cubic foot of (H) hydrogen when burnt consumes ½ cubic foot of (O) oxygen, generating 1 cubic foot of steam, and gives heat enough to raise 1 lb. 13 oz. of water from 32° to 212° F. $2H + O + N = H_2O$.

Carbonic oxyde is generated simultaneously with Hydrogen by contact of red hot coke or tar with steam or by combustion of Carbon in a limited quantity of oxygen, carbonic acid being at the same time produced. The relative amounts of carbonic oxide, and carbonic acid vary with the temperature of the retort, at a white heat carbonic oxide alone being produced.

Water absorbs 1.56 per cent. of its own volume of this gas and it is not in any way affected by lime. It burns with a greater heat than hydrogen, giving a blue flame and very little light.

One cubic foot of carbonic oxide when burned consumed ½ cubic foot of oxygen generating 1 cubic foot of carbonic acid and giving heat enough to raise 1 lb. 14 oz. of water from 32° to 212° F. $CO + O = CO_2$.

Light curburetted Hydrogen is a direct product of the destructive distillation of coal and seems to be produced under a wide variation of temperature. When subjected to a white heat it is slowly decomposed giving twice its volume of hydrogen, and depositing carbon.

When allowed to burn in a large thick flame with light pressure, it gives considerable light. Under great pressure and issuing from a small orifice it gives little or no light. This is a peculiarity also with all the gaseous compounds of hydrogen and carbon and the amount of light derived from ordinary coal gas is dependent in a great degree upon the pressure and size of the orifice from which it issues.

Water absorbs 1.6 per cent. of its own volume of this gas and it is not affected by lime. When burnt one cubic foot yields heat capable of raising 5 lbs. 14 oz. of water from 32° to 212° F.

1 cubic foot consumes 2 cubic feet of oxygen, generates 1 cubic foot of carbonic acid and 2 cubic feet of steam. $CH_4 + 4O = 2(H_2O) + CO_2$.

About 94 per cent. of the volume of purified coal gas consists of the diluents above described. Of these light carburretted hydrogen forms about 33 per cent. of the whole volume of gas, hydrogen and carbonic oxide making together about 60 per cent. These feebly luminous gases serve as the vehicle of the remaining 6 or 7 per cent. of illuminants.

Illuminants.

Olefiant gas or Ethyline, is generated at a high heat, and is a heavy gas, water absorbing 12.5 per cent. of its own volume of it. When subjected for any length of time to a full red heat it is decomposed, hydrogen and perhaps light carburretted hydrogen being produced and carbon deposited. Lime does not affect it. When burnt it gives a brilliant white light without smoke, 1 cubic foot consuming 3 cubic feet of oxygen and generating 2 cubic feet of carbonic acid besides 2 cubic feet of steam. $C_2H_4 + 6O = 2(CO_2) + 2(H_2O)$

Acetylene, is generated at a very high heat; its solubility in water is not determined but it is probably greater than that of olefiant gas. It has been produced by the passage of the electric spark between carbon points in hydrogen gas, is very stable and does not deposit carbon in the retorts, and when united with less highly carburetted gas, burns with a white smoky flame.

1 cu. ft. when burnt consumes 2½ ft. of oxygen, generating 2 cu. ft. of carbonic acid and 1 cu. ft. of steam.

$C_2H_2 + 5O = 2(CO_2) + H_2O$.

Propylene, also called Tritylene, is best produced at a high heat, but is rapidly decomposed at a red heat.

Water absorbs about 12½ per cent. of its own volume of it, and it burns with a brilliant flame, giving 1½ times as much light as Olefiant gas.

1 cu. ft. consumes 4½ cu ft. of oxygen generating 3 cu. ft. of carbonic acid and 3 cu. ft. of steam.

$C_3H_6 + 9O = 3(CO_2) + 3(H_2O)$.

Butylene is produced by a heat which may vary from ordinary redness to that of the electric spark; it was first discovered in rancid butter, and is what gives the disagreeable smell to that substance. Like Propylene, it is rapidly decomposed at a red heat and in the absence of oxygen, depositing carbon; its solubility in water is not known, but it burns with a brilliant flame, giving about twice as much light as Olefiant gas. 1 cu. ft. consumes 6 cu. ft. of oxygen generating 4 cu. ft. of carbonic acid and 4 cu. ft. of steam.

$C_4H_8 + 12O = 4(CO_2) + 4(H_2O)$.

Owing to the extreme difficulty of investigating their properties and composition but very little is known of the illuminating hydrocarbons, and there is doubtless a large number besides these which we have so imperfectly described.

Impurities Sulphuretted hydrogen is derived from the iron pyrites found in greater or less quantities in all coal, the pyrites yielding one atom of sulphur to the nascent hydrogen. It is generated at all heats above red when oxygen is not present. Water absorbs about 2½ times its own volume of this gas and lime forms with it Sulphide of Calcium, or perhaps a higher than the proto sulphide.

1 cu. ft. of consumes 1½ cu. ft. of oxygen generating 1 cu. ft. of sulphurous acid and 1 cu. ft. of steam.

$SH_2 + 3O = SO_2 + H_2O$.

Sulphurous acid is irrespirable and suffocating, and occasions violent coughing when breathed; it is also a powerful bleaching agent, injuring the bindings of books, frescoing on walls, and in the atmosphere it oxidizes to sulphuric acid, thus destroying the texture of such articles as may come in contact with it.

Carbonic acid is produced by the combustion of carbon in an excess of oxygen, or by the decomposition of steam by red hot carbon in the absence of oxygen. As the heat increases less carbonic acid is produced, carbonic oxide being the greater product. Water will absorb its own volume of it and for lime it has a very great affinity, forming ($Ca CO_3$) and being able to displace the sulphides of lime.

It is an incombustible gas and will put out fire; it is irrespirable and will not support life, although not so poisonous as usually thought to be, the poisonous effects credited to it being generally due to carbonic oxide. 1 per cent. of carbonic acid in gas will reduce its illuminating power 6 per cent., so that it is important to free gas from every trace of it.

Ammonia, is generated in the destructive distillation of coal or any organic substance containing nitrogen.

Water at 60° Fah. will absorb 78 times its own bulk of it and lime will take from its salts their acids, setting it on fire as a pure gas; it can not be burnt in the open air, but a small jet in oxygen will burn, producing steam and Nitric acid.

$2(NH_3) + 8O = 3H_2O + N_2O_5$.

Cyanogen and Sulphocyanogen are obtained in small quantities in the distillation of coal. They are somewhat soluble in water and are not decomposed at a high heat unless in the presence of iron, when they are resolved into their elements. Both immediately form salts with ammonia and are carried off in solution in the gas liquor, and methods have been patented for obtaining them from the liquor but have not proved to be practically profitable.

Oxygen and nitrogen are probably obtained by leakage in the apparatus for making gas; they are not eliminated by the process now used in puifying gas and are often the greatest source of trouble where a high standard of illuminating power is required.

When the gas leaves the condensers it usually contains about 1½ volumes of ammonia, 8 volumes of sulphurretted hydrogen and 25 volumes of carbonic acid in every 1000 volumes of gas. Several of the impurities unite with the ammonia forming salts; sulphuretted hydrogen formiug sulphide of ammonia and perhaps higher sulphides, of which there are a large number, Carbonic acid forms carbonate of ammonium; Cyanogen forms cyanide of ammonium; and Sulphocyanogen forms sulphocyanide of ammonium. Of these salts carbonate of ammonium probably forms the greater part as carbonic acid has a greater affinity for ammonia than Sulphurretted hydrogen, and exists in 8 times the quantity, these two impurities being almost the only ones which are in sufficient quantity to be noticed practically.

The nitrogen and oxygen are probably introduced as air while charging the retorts, or where the exhauster is used, through leaks which may occur in the main, leading from the retorts to the exhauster or in the retorts themselves.

Coal Tar consists of Naphtha, coal oil, and pitch, and each of these three substances consists of a number of compounds which have been only partially separated and examined by a most tedious process of distillation. They are very valuable in the trades and as they are becoming better known are put to a wide variety of uses, but being always sold by Gas Co's as Tar, they are of very little interest to the Gas Engineer.

The quality and quantity of gas obtained from any given coal depends in a large degree upon the precautions used in the process of manufacture, which will now be described, as commonly followed in the gas works of the United States.

The coal used must fulfill two conditions, the first of which is to give in sufficient quantity a good quality of gas free from an excessive quantity of sulphur; the second, is to give a coke which is capable of heating the benches to the proper temperature. To obtain a coal fulfilling both of these conditions is often impossible, and the engineer is obliged to resort to mixtures of different coals, possessing one or the other of the desired qualities.

Before introducing the coal into the retort it should be broken into lumps not larger than a man's fist, and slack cannot be used except where a high heat is obtained in the retorts as it cakes together, and is drawn from the retorts in an imperfectly distilled state.

The method of charging now most commonly used in large gas works is by means of an iron scoop which is about the length of the retort and contains the weight of coal used at one charge in a retort. After being filled it is lifted by three men, two placing a bar under the middle and the third grasping the handle; it is then raised to the required height and rapidly thrust into the retort, turned over and withdrawn, leaving the coal distributed throughout its whole length. After a few weeks practice the men become very expert and prefer it to charging with shovels, a method which is not used by many engineers at the present day as it is less expeditious.

(To be continued.)

*A Paper read before the Engineers Club of St. Louis, April 30th, 1873.

THE ASHTABULA DISASTER.

We have but little to add in the nature of evidence to what we wrote last week. The investigation of the coroner's jury has been for the most part on facts not immediately connected with the cause of the accident and the evidence brought before it has been quite unsatisfactory and often conflicting.

We notice further in the evidence of the engineer of the first locomotive that he heard the "sleepers" snapping. (Another report says that he heard the bridge snap behind him and saw the second engine sinking). The general evidence, so far as it relates to the bridge, seems to imply that it broke in the middle and went down bodily. This of course is so far mere opinion, formed at a time when the opinion of most men would be valueless.

The idea that the bridge broke suddenly with a loud snap as if some important member gave way, as a pin, chords, main ties, or posts, and went down immediately, is inherently improbable, and we would not consider the question had it not been seriously broached.

The train was moving at the rate of ten or twelve miles per hour, and at the time of the accident the first engine was from 45 feet to two car lengths from the end of the bridge. Thus the train was moviug from 15 to 18 feet per second, and even if the first engineer did pull his throttle wide open and break loose from the train he could scarcely have cleared the bridge in less than two seconds. On the sudden snap theory the bridge in that time would have been 64 feet toward the bottom of the chasm. So in whatever way the bridge gave way we are obliged to infer that it settled or overturned quite slowly at first.

Mr. Geo. M. Reid, Supervisor of bridges on the Lake Shore road, testified that he had made a specialty of bridge building and inspection for the past twenty-five years, that he personally inspects all the bridges on the road several times a year, and that he inspected this bridge in September last—had not seen the wreck. He found the bridge in good condition and thinks no defect could have escaped his observation. He had always regarded it as a strong, firm bridge and it had never required any extraordinary repairs. Had no theory in regard to the disaster,—had discovered loose bolts twice in inspecting the bridge.

Mr. A. L. Rogers, a carpenter in the employ of the Lake Shore road, had been delegated by Mr. Reid to inspect the bridge over Ashtabula creek from time to time. Inspected it last in October,—found it in good condition—had never found anything out of repair about the bridge—was foreman at the erection of the bridge—his work was inspected by Amasa Stone, then president of the company who took charge of the building of this bridge, Mr. Collins, chief engineer of the company, taking no part in its constructien—was aboard the train in the smoker at the time of the accident—did not think the train left the track before the bridge fell—his theory is that the "second engine jumped the track and threw the bridge out of line, weakening it, when the weight of both engines caused it to break."

This is all the additional evidence we have at this writing. On Monday of this week, the coroner's jury appointed experts to examine into the present condition of the bridge in order to determine the cause of the accident. It will probably be some days before their report is made up.

In the meantime we learn that the new bridge, removed from Cleveland, was completed on the 10th inst., tested, and the regular traffic resumed.

In addition to the above, we have learned that the bridge truss had a supplementary arch, as was common to the earlier forms of Howe truss, and that it was erected to take the place of several wooden Howe truss spans, all the space, except that to be occupied by the iron bridge, having been filled in with bank. Mr. A. L. Rogers, who was foreman at the erection of the bridge, says his work was inspected by Amasa Stone, and that "during the first two months after the bridge was built, before it was used, it settled six inches by its own weight. It was raised with great care, and retained its proper position with a camber of about six inches. The false frame was removed in November, 1866. It was then pronounced perfectly safe."

The New York *Herald* reports, on what it considers reliable authority, that when Mr. John Towlinson, now director of Canadian lighthouses, submitted the plans to Mr. Amasa Stone, then president of the road, Mr. Stone insisted upon some material changes in the plans, to which Mr. Towlinson strenuously objected, declaring that he would not hold himself responsible if the proposed changes were made. "The bridge was erected on the modified plans, and when nearly completed, it was found that the structure was too short to span the space between the piers, and for three months the work remained untouched. At the end of that time the bridge was completed. It was built in the car shops of the company."

As the bridge was built over ten years ago, it is possible that considerable cast iron may have been used, as was common even in bridges of later date, and that it was designed for a lighter running load, the weight of engines commonly used having materially increased in the past few years. It is but a few years since all the iron bridges on the Erie R. R. were removed, as a measure of safety, and replaced by stronger and more modern structures, owing to the increased engine weights which had come into use. This move, we believe, was not suggested by any accident, but only as a needful precaution.

We note a curious coincidence in connection with the Ashtabula disaster. The train left New York at 8:30 P. M., arriving at Albany at 1:30 A. M,. when it split, one part going north to Montreal, and the other going westward to its fate at Ashtabula. The Montreal train went through a wooden bridge 150 feet long, spanning Otter creek, near Pittsford, Vermont, and was wrecked, we believe, without loss of life.

Numerous minor accidents have been reported from all parts of the country, due in a measure no doubt, to the increased inte est excited by the Ashtabula accident, and possibly an actual increase from the remarkably severe winter weather that has everywhere set in so suddenly. Among them we notice that a passenger train on the Kankakee road ran off the track last week on the bridge over the Kankakee river. The cause was a broken rail on the bridge. No particular harm was done except that one passenger was thrown through the car window, receiving some scratches.

The Angola accident has not yet passed from memory and was regarded at the time as almost without parallel. It occurred about 3:30 P. M. of Dec. 18th, 1867. The weather had been very cold and considerable snow was on the track. The east-bound train passed Angola station about twenty-one miles west of Buffalo on the Lake Shore road, at a speed of twenty-five miles per hour, being some two hours late. As the train left the double track the broken flange of a wheel of the rear car caught the frog, the car was derailed and went bumping along over the ties. An attempt was made to stop but being on a down grade and the track slippery before the train could be brought up, the rear car swung over the bank at the Big Sister creek, and making a complete somersault, crashed down to the frozen stream forty feet below. The car next before rolled down the opposite side of the embankment twenty-five feet and rested on its side.

The first car that jumped the bank, ended over, piling the passengers down on the stove, and finally fell over on its side, catching fire almost immediately. It is supposed that there were over fifty passengers in this car only three of whom escaped. The second car caught fire twice and was finally extinguished. Fifty-two are known to have been killed in all or died of their injuries, and the total number of killed and wounded reached nearly a hundred.

THE NEW YORK CANALS.

The Canal question is likely to come prominently before the New York Legislature. The business of the main lines has shown a great falling off, and, although the tolls have been low, a still further reduction is asked for. The Buffalo Board of Trade has asked that only sufficient tolls be taken to provide for the repairs, thus cutting off the State from any prospect of revenue. This request is an admission that the canals have failed to do what was expected of them. A writer states: "The constitution, as adopted in 1846, provided that, after paying all ordinary expenses of the canals, there should be set apart annually $1,300,000 of the surplus canal revenues until the year 1856, and after that $1,700,000 a year, as a sinking fund to pay the canal debt; that after complying with this provision, when the canal debt is paid, $1,500,000 shall be set aside annually from the surplus canal revenues for a sinking fund to pay other State debts; and that, when this provision also is complied with, there shall be paid annually out of surplus canal revenues $200,000 to defray expenses of the State government; the remainder to be applied for enlarging and finishing the canals. Now, thirty years after the adoption of these provisions, during which the State has paid about $15,000,000 in direct taxes for canal purposes, we find an unpaid canal debt (according to the last report) of more than $8,000,000, the canal revenues decreasing, and canal interests calling on the State for help, instead of helping the State themselves."

The management of the canal ring is one of the causes of this condition of things, a cause which is now probably removed. The railroad war of the last season brought freight charges so low as to be most damaging to lines of water carriage, with their slow speed and hence great loss of time. The lateral canals have been a burden. The partial introduction of steam canal boats has not turned out favorably: not because they did not work to advantage and without injury to the canal, but because business was lacking.

If the canals cannot be made to pay their own expenses, it is suggested that they should be sold. No business man would retain property on which he was experiencing a continual loss, and if careful and economical management by the State cannot make them pay, they ought to be disposed of to parties who might believe they could make them do so, if such persons can be found.

THE frightful accident at Ashtabula has aroused the public to the belief that efficient measures ought to be taken to better provide for the safety of railroad travelers. We notice that at Columbus, Ohio, a joint resolution was introduced in the legislature, instructing the governor to appoint three competent engineers to inspect the prominent railroad bridges of the State, and was laid on the table to be discussed. At Washington, Mr. Wilson, of Iowa, offered a resolution requesting the Committee on Railroads to take into consideration and report whether it is wise and expedient to provide by law for the appointment of a National Board of Engineers, to supervise the construction of inter-state railroads, so far as safety to travelers is concerned. The expediency of urging such action as this was discussed at considerable length by the American Society of Civil Engineers some two years ago, and several of its members strongly advocated such a step.

OUR 'Specially to Land Surveyors" has created no little stir among our brethren of the compass and chain, and we have received more valuable hints for our future guidance within a week than for the whole of the past year. The tenor of the article in question has been somewhat misunderstood—the word "contempt" as applied to any class of community that lives by honest labor is not in our vocabulary. Much less is it as applied to the profession from the practice of which we have personally, drawn a very fair income for the past thirteen years, or to the great body of the intelligent, conscientious, and industrious members of that profession, with many of whom we are personally or by correspondence acquainted. We simply stated our experience as a publisher, and if a feeling of disappointment added a little gall to our thoughts as expressed, it does not change the facts. We are satisfied, however, that it will have a good effect all around—we know that we have learned something about our own shortcomings, of which we might have otherwise remained in blissful ignorance but for the "stirring up" we have given to certain of our readers; on the other hand, we hope it will not be forgotten that we are publishing a paper to *make money*, and that very naturally our energies will be directed especially in the direction from which we hope to draw the greatest amount of that very convenient commodity. We now think that from what we have learned in the past week, and what we will most likely learn in a week or two to come that we can make ENGINEERING NEWS truly a surveyors' paper at the same time that we make it particularly a *business* journal, one that will commend itself to the classes for whose benefit we have especially designed it.

THE governor of New York in his message does not see the utility of a *State survey*. He cites, among instances of a pernicious mode of legislating, the provision in the supply bill of the last session for instituting and organizing "an accurate trigonometric and topographical survey of the State." "Without any application by the people," he says, "with no appreciable evil to remedy, with no practical inconvenience in the experience of a hundred years, and at a period of great pecuniary embarrassment, a plan is enacted in an appropriation bill for embarking the State, against the wishes of its people, in a work which promises to run through half a century, and to cost an unlimited amount of money. The mode and the matter of the enactment are alike objectionable, and I recommend the prompt repeal of that portion of the supply bill."

While we do not expect that, with the possession of accurate plans of localities and of large tracts of country, surveyors and engineers will be dispensed with in those places, we do feel as if great advantages might be derived by the local and State governments from having accurate information within their reach. As to getting along without any further services from our profession we are reminded of certain prominent and sanguine citizens of an Eastern place who, upon inspecting a very large and carefully made map of their city, expressed the opinion that, if any of the inhabitants desired to obtain information as to division lines, street lines, grades, etc., they would only have to call in at the City Hall and inspect the plan, and be at once posted on all points. We think there was even some talk of dispensing with the future services of the city engineer.

We have yet to learn that the Ordnance survey of Great Britain is considered and has been found by experience to be a useless expenditure of money. Whether the present time of financial depression is a good one for beginning such an undertaking may be a doubtful question; that it will take half a century to do what is desired, seems an exaggeration.

BARON VON WEBER has called attention to the curious state of things which will result from the construction of the Channel tunnel between England and France, in the way of causing great annoyance to English railway managers. The English railway system is a world of its own; on the completion of the tunnel, England will become a peninsula so far as the railways are concerned, as cars will pass from one shore to the other.

"If the importance of the object to be attained by the channel tunnel is to bear any rational proportion at all to the means required, the tunnel will be constructed only if a very considerable goods traffic between the two shores is expected, besides the passenger traffic. Such a traffic, which would have to compete with the sea carriage, is only possible for goods if shifting the loads is completely avoided, and the wagons and trucks can run from England far into the Continent and *vice versa*. Now the English exports to the Continent far exceed the imports from it. The English trucks, therefore, loaded with rails, machines, coals, cotton goods, etc., will, after passing the tunnel, be scattered far and wide on the continental railways (whose length exceeds threefold that of the whole British system), and will have to run distances five times as great as from London to the Highlands.

"The English railway companies, who are now able to follow their rolling stock almost with the naked eye, who know exactly how long each truck will take to run the short distances in their island, who can, therefore, provide proper loads both for the up and down journeys, hence making the best use of their stock, and who are always aware in whose hands their trucks are, will suddenly see a great number of them disappear out of their sight and beyond their control on long journeys and unknown routes."—*Galaxy*.

A CORRESPONDENT, for whose opinion we have great respect, takes exception to a remark of ours in an article in the NEWS of Dec. 23, p. 387, on Continuous Girders, that "It was necessary to use the single intersection system for the continuous girder, as, with double intersection, the distribution of the shear between the two ties which run on each side to the top of the pier post is indeterminate."

While agreeing with us that there is a certain indefiniteness as to the distribution of the shear in the latter case, he thinks that the same difficulty exists in the case of the single span girder; that the small indeterminateness is practically of no consequence in either case; and that it is not fair to single out the continuous girder for a defect which is common to both. We are ready to allow that the indeterminateness as to the distribution on the web members is so small as to be of little or no consequence practically, but we are, with our present light, unable to see why the stress on each of the two ties which come together at the pier post of a single span truss is not definite in amount, unless the two systems which make up the double intersections cannot be separated in the analysis, by reason of the counter ties of one system being joined to the main system of the other. With two independent systems, as usually designed in the double quadrangular truss, a weight at any panel joint has but one plain path to travel to each abutment, and hence we know over which tie in the first panel each portion of the abutment reaction comes.

In the continuous girder, a load on one span affects other spans, the reactions at other piers besides those nearest the loads are changed, therefore the shears are changed and, as the amount of vertical force transmitted across an unloaded span has two paths open to it over two sets of ties, we have seen no reason for deciding that it must go over one path rather than the other. But, as we stated just now, the question is of but little importance.

MEMORANDUM CONCERNING BLASTING OF ICE IN THE WINTER OF 1875.*

During the winter of 1874–5, the ice formed to an extraordinary thickness in all the streams of the west. Towards spring apprehension was quite widely felt that if there should fall a warm rain for two or three days, the rivers would rapidly rise and carry out the heavy ice, sweeping bridges and all other obstructions before them.

The most exposed structure on the Illinois Central Railroad, was the bridge over the Kankakeé river, a Bollman iron truss, of three spans 170 feet each, and two 60 feet spans. About one hundred feet below the bridge is a dam, and during the winter the water stood about three feet below the top of this.

It was thought desirable to break up the ice above the bridge as soon as the water should rise sufficiently to flow over the dam, so that it might pass between the piers in small masses without danger of gorging.

On the 22d of February there were indications of a thaw, and a gang of men with ice tools were put at work cutting the ice near the bridge into cakes fifteen feet square. Preparations were made also for blasting the ice with gunpowder. Two experimental blasts were made, using in each case a six-pound can of rifle powder. A waterproof fuse sixteen feet long was inserted and carefully packed with putty, the can was securely fastened to the end of a two by four scantling twelve feet long, and the fuse attached by twine to the scantling. A hole of sufficient size to allow the can and attachment to be put through was cut in the ice and the can was pushed under twelve feet beyond the hole, being kept against the ice by the float.

The result of each explosion was to break into small pieces a portion of the ice field about fifteen feet in diameter, and to visibly crack the ice, below its surface in several places, for a distance of some twenty feet beyond the broken center. A number of pieces were thrown fifty feet or more into the air. The ice was twenty-six inches thick.

These results gave confidence in our ability to effect a rapid disentegration of the ice. Further experiment was desirable, however, to determine the proper quantity of powder to be used in each charge to secure the greatest execution.

A number of ordinary one-quart oyster cans were procured, and next day several more blasts were discharged. These cans when filled held, each, one pound and three quarters of F F Fg sporting powder, and this charge gave the best results, breaking up the ice for a space about thirty feet in diameter, and throwing out cracks for thirty or forty feet more. The greatest execution was done when the blasts were exploded at a considerable distance from the places previously blasted out, that is, in the unbroken ice field. A charge of one pound of powder did not fracture the ice. A 6¼ lb. can of Dupont's sporting powder opened a hole 30 ft. in diameter and threw many pieces of ice, several feet square, perpendicularly into the air, probably to a height of 150 feet, the fragments falling within a radius of 100 feet. The seams in the ice, however, were not opened to any greater distance than in the 1¾ lb. charge. Ordinary blasting powder was tried, but it did not break through the ice. A charge of nineteen lbs. had the effect to raise the whole mass of ice extending across the river several inches, but without producing a fracture. A similar charge exploded six feet below the surface had no immediate perceptible effect.

After the explosion of these charges, however, the ice for a distance of five or six hundred feet up the river appeared to be seamed with cracks and ready to go to pieces.

I had been told by a gentleman who had tried to blast ice, that it could not be done, that the powder would not break a hole through the ice. Our experience would indicate that his failure arose from the use of ordinary blasting powder, which does not explode with sufficient rapidity.

The cans used with the 1¾ lb. charges were ordinary oyster cans, the round cover being cut in the center with a +, and this punched through from the inside. The four projecting points encircling the fuse being turned back a little seemed to retain the putty packing in place.

The thaw continued during three days and the river continued to rise, though slowly.

Before the rise was sufficient to move the ice, the weather grew colder, and the river did not break up till more than a month later. During the intervening time the ice was much weakened by the sun and by the gradual draining of surface water into the river. Little apprehension was felt at last, but the precaution was taken to plow the ice with ice plows, for a considerable distance above the bridge, so that it would break up into cakes of a diamond shape, about one hundred feet in length.

On the 28th of March, the water was four feet deep over the dam, and the ice went out. For the most part it broke into the cakes as plowed, but several times during the day there was a disposition to gorge at the bridge. One or two blasts with one and three quarter pound charges, however, had the effect each time to break up the ice so as to keep it in motion. No injury was done to the bridge or to the piers. The ice was about eighteen inches thick when the river broke up.

*Paper read before the Civil Engineers' Club of the Northwest, Jan. 2d, 1877.

Extract from a letter addressed to the Secretary of the Civil Engineers' Club of the Northwest, by Col. F. U. Farquhar, U. S. Engineers. St. Paul, Minn.

* * * * In March 1875 we found that our turbine wheel was not doing as well as it ought to, and on examination the cause was found in the immense thickness of the ice, which in some places was frozen to the bottom, and leaving only a very small channel for the water to reach the turbine. The extreme thickness of the ice was no doubt produced by the freezing of layers of water on top of ice already formed. It was decided to cut a channel through the ice from the foot of the mill-pond to the open water in the river above. A hole was cut through the ice and it was found to be five feet (5′) thick. After a little work by hand, the tools being axes, picks and pike poles, it was determined to try the effect of dynamite, as we had a small amount on hand. The result was very successful. A ½-pound cartridge was fastened to a pole about 10 feet long. A Brown's exploder had been inserted in the cartridge and the wires from it carried along the stick. The cartridge was pushed up under the ice as far as the stick would allow. The end of the stick was made fast to the ice at the opening and the wires carried to a safe place and connected with the poles of a friction battery. The battery was charged and the cartridge fired. The result was that, while no hole was blown through the ice, it was broken up so as to be easily removed with pike-poles for a space of about 10 to 12 feet in diameter.

* * * The Minneapolis Boom Co. used the same means to open a channel and start the ice from above the dams before the rise of the river. For thinner ice a slower burning explosive would be better than dynamite. I have not the means at hand to give the cost, etc., of doing the work but only know that it was a very rapid way of getting it done. * * * * *

SURVEYOR MONOPOLY.

To the Men of the Profession of Surveying:

Being known as a certain fact to the writer of this article, that a certain newly elected State Senator of one of the lower districts of this State and particularly influenced by an ignoramus of a lately elected County Surveyor, totally unqualified for the fulfillment of his duties, is about ready to introduce as his first act a bill to the effect "that none but a duly (by the voice of the people) elected Surveyor, whether qualified or not, shall be permitted to execute any survey or county engineer-

ing work within the limits of the county; neither placing him under bond or requiring any qualification."

The present surveyor law as in force in our State (Cook County excepted) in which county licensed surveyors have the same power as county surveyors, gives some power to the non-county surveyor, that is, it does not exclude him from executing any work, but in most cases, through the ignorance of the farming population, most of the work, and all of the county work goes in the hands of the county surveyor, hardly ever considering his ability.

Under the present law, and as it has been the case in our county (in which a very experienced surveyor is wanted to operate) men, entirely unknown and unfit for the office, men who had no idea of the use of a common compass, or who never studied the first rudiments of geometry and algebra, and had hardly a common school education—by political trickery are elected to the office, and are afterwards the cause of many troublesome lawsuits. In order to keep the professional surveyors from executing any work the surveyors' records are sometimes destroyed or taken away to a place unknown to them, and by these means forcing the people to employ the county surveyor. In the county where I reside a great amount of *crooked* surveying is done, and has been done by the county surveyor, and the intelligent land owners try to seek relief by praying the intelligent surveyors and engineers of this State to co-operate and do something so that the professional surveyor will have a chance to execute surveys legally.

Fellow Surveyors! Let us unite as soon as possible in Springfield, on some day during this month, if possible on the 15th or 22nd, to discuss the present condition of our surveyor's laws and see what can be done in order to improve them. Let us use our influence towards inducing the present Legislature to do away with our present surveyor law and follow in progress the surveyor's laws in force in the city of Chicago.

CHAS. A. M. SCHLIERHOLZ, C. E.

MONROE Co., Illinois.

The present law of the State of Illinois requires only that a surveyor shall be "competent" in order to allow him to make surveys and subdivisions in any part of the State, including Cook Co. and the city of Chicago. What is desirable now is to *prevent* any further legislation, and concentrate any efforts for improvement in abolishing the *name* and *office* of *County* Surveyor, for, as the writer of the above appeal states, ignorant people imagine that the county surveyor is the only person authorized to make legal surveys, whereas he has no such privilege.—[ED.]

COAL GAS.*

BY WM. D. MARKS.

(*Concluded from page 10.*)

Four hours is the usual time that a charge is allowed to remain in the retort before being drawn. Five, and even six hours, occasionally is the time for which a charge is left in a retort, but after four hours the gas is of very low illuminating power and distilled in small quantities and not worth the fuel.

It is of paramount importance to keep the pressure in the retort, equal to that of the atmosphere outside or even a little less, and the heat of the retorts high, an orange yellow being considered the best temperature for clay, at which high heat it is considered that less tar and more gas is obtained from coal than at the lower temperature formerly used when iron retorts made them necessary.

The pressure is regulated by means of an exhauster, which rapidly withdraws the gas from the retorts when made, and prevents their incrustation by the carbon derived from the illuminants, which it is the first object of the engineer to secure.

The first of the purifying apparatus into which the gas enters is the condenser, where it is cooled to the temperature of the atmosphere, and where also it deposits most of its tar and oily hydrocarbons which have been brought over in vapor. On entering the scrubber which follows the condenser—the gas parts with its tar and a portion of its gaseous impurities,—carbonic acid, sulphuretted hydrogen and amonia—the amount of which is uncertain. Foule's experiments at Breslau in 1860 would indicate that in every 1000 volumes of gas there is detained in the scrubber 6 volumes of carbonic acid, 10 volumes of sulphuretted hydrogen and 10 volumes of amonia.

The lime purifiers, which are the last of the purifying apparatus, take up the remainder of the carbonic acid and sulphuretted hydrogen in the proportion of about 30 volumes of the former to 5 volumes of the latter.

Thus—neglecting the small quantities of the illuminating gases which are mechanically arrested in the apparatus—we have left of the original 1000 volumes of gas, 930 volumes which latter is increased by air unintentionally introduced during the progress of the gas through the apparatus.

The gas is now measured by the Station Meter and goes to the gas holders where it awaits distribution.

In the matter of distribution, which is an important one, there are several points to be noted. Great pains must be taken to secure a perfect pipe system so that every district shall have an abundant supply. The consumers must have all the gas they want. It is a very common but poor policy to have pipe so small that consumers cannot get all the light they wish at the very time they most desire it. As gas is coming into use for heating and cooking purposes, that of abour 14 candle power will be found to be the most economical for consumers, when used for illuminating purposes also.

Gas companies ought to encourage a large day consumption.

In constructing works it is best to put them up as conveniently and handsomely as possible, as it raises the standard of the officers, prevents a lot of shanties from growing up around the works, and does not lower the value of surrounding property.

I can perhaps do no better than close this paper by a short description of the Laclede Gas Works as now erected in this city, (St. Louis).

February 2nd, 1872, the company purchased about five and one-half acres of ground situated at the foot of Howard street and between Main street and the Mississippi river.

The limestone formation at this point either crops out at the surface, or at the most—with the exception of a filled up quarry—is but a few feet below, thus affording a perfect foundation for all such buildings as are erected, but adding to the expense of the connections in the yard, which have to be laid in trenches blasted from the solid rock.

The North Missouri railroad has a right of way thirty feet wide through the ground, and the Transfer Co. has its ferry landing at the foot of Mullanphy street immediately south and adjoining it.

The water front on the river is about 439 feet in length, so the company had ample facilities for the delivery, either by rail or water, of all coal needed.

The Retort House is built entirely of stone and brick laid in cement mortar, and iron, and is from the designs of Wm Farmer, Engineer, of New York City.

This building has a front of 119 feet and a depth of 103½ feet. The height from the bottom of coke cellar to the eaves of the roof is 38 feet.

The outside walls of the coke cellar are built of coursed rubble two feet thick and reinforced at the front and rear of building by counter forts 36 by 24 inches at the base placed 18 feet 6 inches apart.

To this cellar at the ordinary level of the ground are sixteen arched entrances for wagons, ten feet wide and twelve feet high.

In the interior are two lines of brick arches upon stone piers, which support the benches; these benches which are at the level of the firing floor are in sets of five, and there are at present one hundred retorts set, which will have a maximum of 600,000 cubit feet. During the ensuing summer a second stack of benches of equal capacity will be built.

The firing floor is made of cast iron plates riveted down to wrought iron girders and immediately under each mouthpiece is a wrought iron trap-door to allow the coke to fall into the cellar when the retorts are drawn; this floor will be reached by means of 2 hydraulic lifts of 16 feet lift, the coal being brought into the Retort House in dumping barrows.

The roof to this building is made double, with a valley gutter and 24 trusses, each constructed with 12 principal trusses placed 7 feet 10 inches apart from center to center having a span of 59 feet.

Angle iron purlins are placed 8 inches apart between the principals, and the slate is fastened to these by lead nails.

Following the 29-inch main which takes the gas from the Retort House, we next come to the building in which the gas is purified and measured, and in which, contrary to former custom, all the apparatus are placed in the most compact form.

This building is 132 feet deep, and has a front of 64 feet 6 inches; it faces, and is on Main Street, the offices of the engineer and book-keeper being to the right and left of the front entrance while the station meter occupies the vestibule, which is tiled with marble and paneled with black walnut, and presents a strikingly elegant appearance: above the offices are two rooms which will be used for drawing, meetings of the officers of the company and such similar purposes.

The gas on entering this building first passes through the Multitubular Condenser, a cast-iron tank with a base 5 feet 10 inches by 21 feet 8 inches and 15 feet high; this tank contains 400 3-inch pipes, 11 feet 7¼ inches long, through which the gas is obliged to pass, and these pipes are arranged in four stacks of one hundred each and cooled by water, which is constantly passing through the tank.

The Liversy Scubber to which the gas next comes is a square cast-iron box 6 feet 8 inches by 6 feet 8 inches external dimensions and 24 feet high. In the interior of this box are placed on edge and very close together, slats six inches wide by one-fourth inch thick. Water is allowed to drip from the top while the gas comes from the bottom.

The horizontal engine used to drive the Root's exhauster is of twelve-horse power. In the same room with the engine and exhauster are placed a Lowe's Jet Photometer and pressure and vacuum gauges, which two last communicate with the outlet of the exhauster and directly with the Hydraulic Main, so that the engineer will always have the power to so regulate the exhauster as to keep the gas within ½ candle of any fixed standard of illuminating power.

From the exhauster the gas goes to the dry centre seal and through the purifying boxes; these boxes are twenty feet square and contain seven tiers of rattan lime trays, each box holding about seven tons of slackened lime.

The case of the Station Meter used is eleven feet internal diameter, and an eight-day clock with tell-tale movement is placed over the index.

The tanks for Gas Holders are ninety-seven feet in internal diameter——inches thick at bottom and diminished to 24 inches at the top which is covered by limestone coping. Their depth is twenty-five feet six inches, and the bottom, which is solid rock, is covered first with clay puddle and then with concrete in two coats, each six inches thick. All brick are laid in cement mortar, one-third cement to two-thirds sand, and each course grouted with liquid cement, the outside of tank walls having a coating of one-fourth of an inch thick, and being filled in with clay puddle around the whole outside.

The two gas holders are telescopic and built with a flat top without trussing.

The inner or upper sections are ninety-four feet in diameter and twenty-five feet deep; it is fitted with a grip or reversed cup at its upper edge which grasps the hydraulic cup when it has risen to its full height.

The columns for each holder are eight in number, fifty feet in height and——inches in diameter at base, and in the interior of each are placed the counter weights for the lower lift of gas holder and they are connected at the top by lattice girders three feet deep.

Each of the holders when at its full extension will contain 350,000 cubic feet of gas.

*A Paper read before the Engineers Club of St. Louis, April 30th, 1873.

CORRESPONDENCE.

TORONTO, *January 4th*, 1877.

Editor ENGINEERING NEWS:

SIR:—Application will be made at the next session of the Parliament of the Domin on for Power to construct a bridge across the St. Lawrence at or near Quebec, for the passage of railway trains and ordinary vehicles.

A meeting of architects took place here on the 28th ult. for the purpose of organizing an Architects Association for the Province of Ontario. After electing Mr. T. J. Rastrick, President; Mr. Langley, vice President; Mr. Smith Treasurer, and Mr. Frank Darling, Secretary, a Committee was appointed to draft a constitution and by-laws. The Association then adjourned to meet again soon at the call of the secretary.

The town of Guelph is to have a street railway connecting the passenger stations of the Grand Trunk, and Great Western Railways, which are situate on opposite sides of the town.

In order to ascertain as correctly as possible the condition and extent of the Oil production of Ontario, a London paper recently sent a special and well qualified reporter to Petrolia, where he spent several days in collecting information. From his long and interesting report just published, I glean the following:—There are 308 pumping wells in the Canadian oil regions with a

daily production of 1179 barrels. In addition there are 43 drilling and preparing to drill, and 17 preparing to "start up." The total consumption of crude oil in Canada is fully 70,000 barrels a month; at present the yeild does not equal the consumption. The stock on hand at Petrolia is about 175,000 barrels. The average cost of simply drilling a well, is fixed at $175. With machinery and general appliances, the cost is about $1.300.

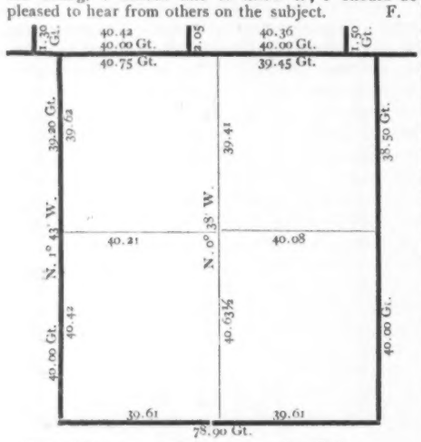
Several deaths having recently occurred at our railway stations through pedestrians getting their feet caught in the 'frogs," it is suggested that Parliament should make railway companies liable for heavy damages in all such cases; and also, if possible, force the companies to employ some less dangerous creature than the *frog* aforesaid, to secure the crossings of their tracks. Should not legislation go a little further and provide for the punishment of people who will insist upon walking over such parts of railway tracks,—particularly at and near stations—as are intended for the accommodation of trains only? A large proportion of the 'accidents" we hear of result from the carelessness or temerity of the unfortunate victims.

The track of the Hamilton & Northwestern railway is now laid to within a mile or two of Stewarttown, and the company are now advertising for ties for the line between Georgetown and Barrie. CANADENSIS.

CARTHAGE, ILL. *Jan. 4th*, 1877.

Edit r ENGINEERING NEWS:

SIR:—In your issue of Dec. 23rd in the communication from the Land Commissioner, he alludes to the vexed Question of due north. I send you a diagram of a section which is a case in my practice, and desire to call attention to the ¼ section corner on the north side. The Original field notes of the government surveys in this region, show that the North and South center lines of the north tier of sections, should be parallel with the East line of the section and the areas are calculated accordingly; now shall I calculate from the data given me in the original note the distance between the ¼ section corner made for the section north and the corner in Question; or shall I first measure the lines and then adopt a proportional measurement, as stated by the commissioners. My plan has been to set this corner by calculation, but I am not aware to what extent it is done by others. When there is no opposite corresponding ¼ section corner I would run parallel with the east line, and in this case I regard the corner placed by calculations as the true opposite corresponding corner. If I am wrong, I should like to know it; I should be pleased to hear from others on the subject. F.



[We will give our opinion next week.—ED].

BOSTON, *January 1st*, 1877.

Editor ENGINEERING NEWS.

SIR:—Mr. Tubbs can find the information he desires in "The Brooklyn Water Works and Sewers" Van Nostrand, 1867, pp. 78–81. The fomulæ as given there are:

$$D = \left\{ \frac{m^2}{1450\,S} \right\}^{\frac{1}{5}} \quad \text{and} \quad D = \left\{ \frac{m^2}{1450\,S} \right\}^{\frac{1}{6}}$$

in which

M = disch. in cub. feet per second.

S = sine of inclination, or $\frac{H}{L}$.

I transposed and changed the form somewhat. Mr. Kirkwood makes this modification in order to approximate to the experimental results obtained by Roe. He thinks the increased discharge of sewers, above that given by old formulæ, is due to the sharp inclinations of house drains, gully pipes etc., which discharge into the sewers at great velocities; a condition which doubtless does obtain in times of storm, and in settled districts.

I send herewith two diagrams,* showing the relation of Diameters to Acreage, by three characteristic formulæ; each of which is used in practice. Prony, Eytelwein, Darcy and the other old authorit es do not vary much from Weisbach. Mr. Shedd, at Providence, uses a rule almost identical with Kirkwood's.

It may interest your readers who have not looked into the matter, to note the divergence of these formulæ.

ELIOT C. CLARKE.

* These diagrams will be published in a future issue.

SANTA FE, NEW MEX., *Dec. 30th*, 1876.

Editor ENGINEERING NEWS:

SIR: In your paper of the 9th and 23rd ult., your correspondents have revived the witch Hazel subject. (I think it would be impossible to put a well down anywhere in Eastern Massachusetts to a reasonable depth and not find water.)

During the years 1865–66 in the oil regions of Pennsylvania, parties extorted considerable money from confiding individuals, making them believe the witch Hazel had a certain property in the hands of parties of sufficient magnetism to indicate the presence of oil, water, or other valuable products.

I knew many wells to be located by this means, some by parties who secretly believed in it, and yet ashamed to acknowledge that they did so. I myself experimented with the twigs to my entire satisfaction. I will wager that I can take the forked sticks hazel or any other wood suitable to the purpose, hold one end in each hand, the crotch or fork pointing up, then I will walk about and have the point turn over, when passing a given point, and a looker on shall not see the least change or movement in my hand or arm, and when I leave the place it will rise again without any apparent effort. I will then show that the twigs have been held very firmly—somtimes the bark rubbed off in my hands, and apparently considerable force exerted—very likely five out of ten men would believe in it. Vet the hazel turns by my will. I know that it is done by the most impercepurable movement, scarcely noticeable to myself. There are several opposing forces to work. I am not quite certain that Duchaley's method of solving opposing forces would solve this or not. Col. Olcott who has so thoroughly investigated spiritualism, might be induced to look into this, he might not come to conclusions as quickly as some others, but he might make it entertaining, besides assisting to dispel a popular superstition from the enlightened people of New England, which, had it been entertained one hundred and eighty years ago, might have led one to Salem's hill.

"APACHE."

FORT WAYNE, IND., *Jan. 4th*. 1877.

Editor ENGINEERING NEWS:

SIR:—Being a new subscriber, I am unacquainted with correspondence upon sewerage referred to by your correspondent G. M. A. in No. 53, Vol. III. An overworked city engineer is also too busy with the affairs of his office to enter upon correspondence of this nature I, however feel like dropping a line upon this particular matter, and if you deem it of interest you can publish the communication. The fact that the coefficient of friction, C *f*, is found to increase as the velocity decreases, will account in some measure for slight differences in formulæ. C *f*, for a velocity of 1.5 ft. per sec., is .0069914. whence $v = 96\sqrt{rs}$; for *v* of 2 and 2½ it is .0064403. whence $v = 100\sqrt{rs}$; for 20 ft. it is .004556, from which $v = 118.3\sqrt{rs}$. From 30 experiments on canals, where the velocities did not exceed 3 ft. per second, Prony deduced $v = 103\sqrt{rs} - .24$ nearly. For pipes Prony found from 50 experiments made by Du Buat, Bossuet and Couplet, with pipes from 1 to 5 inches diameter, and from 30 to 00 feet long, and one pipe 19 inches diameter and nearly 4000 feet long, $v = 97\sqrt{rs} - .08$ nearly. Prony also makes the following formulæ appl cable to pipes or rivers $100\sqrt{rs} - .15$ nearly. Eytelwein, from experiments on rivers gives $v = 93.4\sqrt{rs}$, and for pipes $v = 108\sqrt{rs} - .13$. D. Aubuisson, from an examination of the results obtained by Prony and Eytelwein, assumes for pipes $v = 98\sqrt{rs} - .1$ nearly. For rivers he assumes $94.5\sqrt{rs} - .11$ nearly. When the velocity exceeds 2 feet per second, he assumes $v = 95.6\sqrt{rs}$. Values found best to agree with the general run of experiments in clear, straight rivers of uniform section is $v = 93\sqrt{rs} - .02$, which, for average velocities of 1½ feet per second, will give $v = 92.3\sqrt{rs}$, and for larger velocities, $93.3\sqrt{rs}$. Mr. Neville's valuable formula, $v = 140(rs)^{\frac{1}{2}} - 11(rs)^{\frac{1}{4}}$, for velocities of 2 feet gives $v = 100.3\sqrt{rs}$, and for velocities from 1 to 20 feet the formulæ varies from $v = 93\sqrt{rs}$ to $v = 120\sqrt{rs}$. The Brooklyn formulæ, $v = 48.5\sqrt{DS}$, or for discharge $m = 38.08\,D^2\sqrt{DS}$, or diameter, $D = \left\{ \frac{m^2}{1150} \right\}^{\frac{1}{5}}$ is reducible to $97\sqrt{DS}$. Eytelwein's formula, quoted by Latham, $v = 93.4\sqrt{rs}$, is reducible to $m = 36.67818\,D^2\sqrt{DS}$.

say $36.68\,D^2\sqrt{DS}$, whence $D = \left\{ \frac{m^2}{1345\,S} \right\}^{\frac{1}{5}}$.

The Brooklyn formula, for acres, with one inch of rainfall, half an inch reaching the sewer in the same time

$$D = \left\{ \frac{m^2}{5804} \right\}^{\frac{1}{5}}$$

Eytelwein's would be, $D = \left\{ \frac{m^2}{5330\,S} \right\}^{\frac{1}{5}}$

Mr. Roes, - - $D = \left\{ \frac{m^2}{5806\,S} \right\}^{\frac{1}{6.4}}$

This is, of course, upon supposition that but half an inch reaches the sewer in an hour. If we supposed that the whole amount, or one inch, reached the sewer in that time, the Brooklyn formula would become $D = \left\{ \frac{m^2}{23216\,S} \right\}^{\frac{1}{5}}$ and Eytelwein, $D = \left\{ \frac{m^2}{21520\,S} \right\}^{\frac{1}{5}}$

and I suppose it is under this latter condition of the formula that G. M. A. figures 37 acres. It will be observed that all the formulæ I have quoted differ only by a small percentage, and as the discharge of circular sewers and pipes are as the 2½ powers of the diameters, a difference in the diameter which in practice amounts to nothing, overcomes this percentage and places the sewer, as regards capacity, on the side of safety.

In my own practice I figure the size according to the different authorities and in the "evening up" can always keep on the safe side. I quite agree with G. M. A. that some of the practice in the western cities would l ad to the supposition that the formula quoted would give insufficient provision for sewerage discharge. I am, however, also satisfied that there is abundant room for improvement in the western practice. and that such improvement would save corporations immense sums of money. I am now engaged at a plan of sewerage for this city, and would be much interested in anything our hydraulic engineers may be pleased to publish upon the subject.

JOHN RYALL, *City Civil Eng'r.*

PAW PAW GROVE, ILL., *Jan.* 8, 1877.

Editor ENGINEERING NEWS.

SIR.—Enclosed please find post-office order for $3.00 for which please send me your paper for another year. Although I am only a land surveyor I cannot think of giving up the ENGINEERING NEWS. In your "Special for Land Surveyors" you seem to think that if we only have a Gurley compass and chain and a few other cheap instruments (I suppose you mean by that an old brass semicircle and boxwood scale with an old pair dividers made of brass and iron), we want nothing else.

This description would be all a land surveyor could afford if kept up by the pay received f r his work, but, so far as I am acquainted, your "Special for Land Surveyors" is entirely overdrawn. I don't know a surveyor of any respectability in this part of the country that uses Gurley's cheap instruments. I have always used Young's and now am using a Young's Transit. The surveyors of De Kalb and LaSalle I know use transits of the best makers, and know how to use them.

I am aware that many surveyors are unworthy of the name and are not acquainted with the first principles of surveying, but we are trying to improve on that grade of surveyors—and we want you to help us all you can. You have given us a great deal of standard information the last year, The knowledge that could be acquired through the columns of your paper is invaluable to the land surveyor, and is just as valuable to railroad engineers, as they, in locating lines of railway, must connect their lines with the government survey, and should also understand thoroughly the mode of dividing sections.

I have perused your paper carefully from the first number to the last, and must say that your decisions in regard to land surveying and especially the divisions of sections are to the point, and if followed closely would keep many a land holder out of the law's clutches. Although running section lines and dividing them up properly is, as you say, a very simple process, yet there are many that practice surveying, and among them engineers of some eminence, one of whom I am well acquainted with, a chief engineer of one of the leading railroads in this state, who divided the N W¼ section 30, the same as he would have done any other section, and had his division line about 4 rods out of the way. Knowledge is what we all want and we want to get it out of ENGINEERING NEWS. Give us something in almost every number, if it is but a line, and you will soon have all the intelligent surveyors supporting your paper, and it makes but little difference where the rest are found. WM. MCMAHAN.

County Surveyor.

THE STEEL RAIL INDUSTRY OF CHICAGO.

We extract the following interesting review of the steel rail industry from *The Chicago Times*, of the 24th ult.

Chicago is now the centre of a considerable rolling-mill interest. Four mills, among the largest in the country, are hereabouts. One of them is even something of a monster, employing as it does when full-handed, a brigade of 1,500 men. At least two of these mills are now almost exclusively—one of them is entirely—devoted to the manufacture of steel rails, and one-fourth of all the material in that line manufactured in the whole country is turned out here. Formerly these mills devoted themselves exclusively to iron products, but now the old order is almost completely reversed. The iron rail is now virtually out of date, and is being replaced by steel almost as fast as the article can be manufactured. The revolution in this respect is in fact so complete that no first-class road could afford to put down iron hereafter, though the material were given to it. The price of steel rails per ton at present is about $55, and of iron about $40. How much longer a steel rail will last than an iron one it is hard to say, for the experi-

ment is not old enough to present reliable data. Some maintain that a steel rail will outwear four iron rails, some that it is as good as eight, others that it is equal to 12, and so on upward, until one need not be surprised to hear men say that a steel rail will never wear out. At the "Centennial" a steel rail was exhibited from Cleveland that had worn out 21 iron rails, and was still in excellent condition. The test was begun many years ago. This steel rail was laid down at a point in the track where it was almost uninterruptedly in use, and opposite to it was placed an iron rail. Now the claim is that the competing iron rail has been replaced 21 times. The Chicago, Burlington and Quincy road reports even a better case. Some steel rails in use in one of their yards have served equal to the durability of 32 iron rails, and are still almost as good as new. On the part of the manufacturers, the rail is guaranteed for five years. When it is demonstrated that a steel rail will outwear at least half a dozen iron rails, it is easily understood why it would not pay a first-class railroad to accept iron rails as a gift. In the first place, the steel rail is much safer,—and the best security is none too good in connection with modern fast time.—and, secondly, the cost of the frequent replacement of the iron rail would soon amount to the full measure of the expense of steel rails. It is only the most slovenly and least-used roads that lay down iron now. In some instances it is, perhaps, quite as good as it needs be. In the case of roads that run only one or two trains a day, and that at a rate that admits of passengers, playing a game of ball by the wayside, iron rails will do very well for 20 or more years. But so would wooden ones.

The manufacture of steel rails in this country used to afford an immense profit. At one time they were as high as $150 per ton, and even as late as 1871 they rated at $125 per ton. Since that time, however, they have been subject to a steady decline,—a sort of galloping consumption, in fact,—until now the price is down to $55, or but a trifle over one-third of the figure that ruled but a matter of six or seven years ago. When this high figure obtained, the manufacture of steel rails was still in its infancy in this country, and nearly the entire supply came across the water from England paying a high duty at the port of entry. As soon as the home manufacture commenced in earnest,—Chicago being among the first to enter the list—the price began to decline, partly owing to competion, but mostly to hard times that immediately thereafter set in. English competition is now virtually ruled out of the market, owing to the tariff, and prices are exclusively governed by home competition. Profits are now almost entirely governed by locality. In other words, this business now is run on such close margins that the question of transportation is the deciding factor. It is only after our own mills are gorged beyond their capacity that eastern manufacturers can afford to come into this market and compete for the western supply. Otherwise the difference in the cost of transportation effectually keeps them out of the field. This being the case, it will be readily appreciated that the rolling-mill interest of the west enjoys a decided advantage over that of any other section of the country. The main lines in the east are already pretty well supplied with steel rail, and the southern roads are too poor to put down anything, but must hobble along as best they can. Hence it is in the west that the chief demand is made and the question of transportation being the deciding factor, it is quite natural that our mills should carry off the palm. Thus it happens that while the iron interest of the country generally is dull to stagnation, we are doing a lively business, and that, too, at a reasonable, and even encouraging profit, so much so, in fact, that the capacity of our mills is continually increasing.

For the manufacture of steel rails Chicago is peculiarly and most favorably situated. Practically she has nothing within her borders that belongs to or enters into the manufacture of steel save the mills and a superabundance of energy and yet we can manufacture cheaper than any other place in the country. The reason for this is that three things enter into the manufacture of steel, and in no instance are all three of these things found at any one place. Two kinds of iron ore are essential, and coal. When the coal is found the iron is apt to be wanting, and the two kinds of iron that enter into the problem are never found together. Now, it so happens that while Chicago has neither coal nor iron mines in her immediate neighborhood, she sits simply "betwixt and between," and thus enjoys an immense advantage, the more so as the transportation rates from one of the iron regions that serves as a source of supply, Lake Superior, are merely nominal. Under these conditions it is more than probable that Chicago will one day become the great steel manufacturing centre of the country.

GLEANINGS FROM CORRESPONDENCE.

It will give me pleasure when my time will permit, to send an occasional article. It should be impressed upon our American engineers that it is their *duty* not to let their experience die and be "interred with their bones;" let them rather, embalm it through the press.

W. MILNOR ROBERTS.

Allow me to express my appreciation of the great value of your paper; it is rapidly becoming *the* civil engineering journal of the country.

MANSFIELD MERRIMAN.

Since the matter of legislation has begun to be agitated, I think it should be so directed as not to be simply in the interest of men who happen to hold the office of county surveyor, but who are not competent surveyors. Would it not be possible to have some sort of an organization among the surveyors, like the Engineers' Club, or at least something by which the better class of surveyors could know each other?

J. G. F., *County Surveyor.*

[We will have something to say on this subject shortly.—ED.]

I have a complete file from the commencement of your paper, and it makes a collection of facts, principles and decisions which I could not afford to be without for five times the price of the paper, especially as I am a young engineer, and have had limited opportunities for studying the higher branches connected with the profession. So, for my part, I am glad to know you are undertaking to publish some of the standard works, and hope they may prove a financial success to you.

S. D.

PERSONAL.

Mr. Carl O. Wederkinch, who did some very delicate and difficult engineering work in the Hoosac Tunnel with great success, and was subsequently employed on the Sutro Tunnel in Nevada, is now in charge of the Silver Islet silver mines on the Canadian shore of Lake Superior.

Mr. Wm. Wickham Reeve, for over sixty years a civil engineer, died at his residence in Middletown, N. Y. Dec. 25th, aged eighty-four years. He was employed in the first surveys made for the Erie and later located the Middletown, Unionville & Water Gap road, and was Consulting Engineer on the Midland.

NOTES.

All work in Fairmount Park, Philadelphia, has been stopped for want of money.

The coast survey boats are all in snug winter quarters at Seattle, Wash. Ter.

The government authorities are still at work on the jetties for the protection of the beach in front of the light house at Atlantic city.

The Hudson County, N. J., Gas Company have made a reduction in the price of gas from $3 to $2.75 per 1,000 feet, to take effect on January 1st.

The Hell Gate improvement has not as yet been of any benefit to New York shipping. The officers in charge complain of want of funds to complete the works.

The survey of the Calumet river through the village of South Chicago, and the establishment of the dock lines has been entrusted to C. McLennan, C. E., of this city. The price to be paid is $600.

The Common Council of Trenton, N. J., were to take action Jan. 2nd toward changing the grade of several streets of that city. In Chicago that means house-raising and street-filling and paving.

1150 feet of cribbing are now sunk in the Cleveland breakwater at an expense of $58,000. The entire length of cribbing proposed is 7700 ft., at an estimated cost of $1,173,000. Work will be renewed next Spring on further appropriation.

The Officers of the Minneapolis Academy of Sciences for 1877 are: President, R. J. Baldwin; Vice President, S. C. Gale; Rec. Secretary, A. F. Elliot, M. D., Cor. Secretary, P. L. Hatch, M. D.; Treasurer, J. B. Clough. Board of Trustees: Dr. P. L. Hatch. Dr. A. E. Johnson and Dr. A. F. Elliot.

Canada, on the 30th of June, 1875, had 4484 miles of railway in operation, which has now doubtless been increased to 4500 or more. In 1850 the amount was only 51 miles; in 1855 it had jumped to 1218; in the next ten years it was nearly doubled, reaching 2231, and in the next decade to 1875, it had again nearly doubled, rising to 4484 miles—a rate of increase about the same as that of the United States. The number of inhabitants in Canada per railroad mile is about twice as great as in the United States, while the number of square miles of area per railroad mile—153—is nearly four times as great; so that there is a much greater field for railroad operations in the Dominion, if only the extent of territory be considered, than in our republic. Owing to the inhospitable climate of much of Upper Canada, however, those regions will not be fully developed until the temperate zone is peopled.

Now, that a thaw has set in the country roads are in that deplorable condition which winter brings, and locomotion is rendered disagreeable and even dangerous. Deep ruts are the carriage tracks and broken springs are quite the fashion. The man who will rise up and invent a system of road making that will overcome the miserable clay soil and give us firm, hard roads for winter travel, will be a savior of his country, and will be rewarded with a statue, by his grateful countrymen We doubt if such miserable roads exist anywhere else in the Union as in this neighborhood. In New York and Northern Pennsylvania snow usually covers up the ruts all winter, and south of us they do not freeze. But in this section, where it is not cold enough for constant sleighing, and yet cold enough to freeze the mud, we are subject to all the horrors of bad roads.—*Wheeling Intelligencer.*

RAILROAD NEWS.

The Detroit, Lansing & Lake Michigan R. R. has been sold under foreclosure for $15,000.

The Allentown, Pa., Rolling Mill Co. have a large contract for a railroad in Cuba.

The Baldwin Locomotive Works are working 1,039 men, chiefly upon Cuban and South American orders.

Myron W. Bailey, of St. Albans, Vt., has been elected Railroad Commissioner of that State for the ensuing two years.

The Cincinnati, Hamilton & Dayton R. R. has established an office of freight foreman, whose duty it especially is to look after the other brakemen and see to it that his freight arrives safe at its destination.

The latest important engineering work is the Bergen hill tunnel, New Jersey, on the line of the Delaware, Lackawanna & Western R. R. It was begun three years ago, and gave employment to a force of about 600 men. It is nearly a mile long, 27 feet wide, and 18 feet high. Two tracks will be laid through it.

"It is said;" "There is talk;" "It is reported;" "We understand;" "A meeting was held, etc.;" "The people of—Co. are somewhat anxious;" "A company has been organized;" "It is announced;" "Subscriptions are being solicited;" "The road is to be built *if* enough subscriptions to stock are received;" "Work is *to be* begun in;" "If;" etc., etc.. *ad libitum* in the *Railroad Journals.* Pretty weak diet.

The San Francisco *Bulletin* predicts a continuous line of railway from Puget Sound to the Gulf of Mexico within ten years. On to Cape Horn!——Here's "business:" The Tulare *Times* of Dec. 16th says of the Southern Pacific,—"The road west of Goshen is being pushed towards King's river as if by magic. Within twenty days fifty miles will be completed."——Railway building seems to be more active in the far west than elsewhere on the continent. At this season of the year very little can be done anywhere but "project."

The *Railway World* has been raveeing the size but increasing the number, of its pages. It is twenty years old. ——The General Supts. of certain Southwestern railroads have been advising their employes to insure their lives. Prudent!——And still the wages of the "grateful and appreciative" employes are being reduced.——Receiver Grinnell, of the Iowa Central, presented a Christmas turkey to each of his engineers.—29 turkeys. Generous!——There is a "jerk-water" train—whatever that may be—on the Iron Mountain Road.——They are still "signing contracts" to build section 15 of the Canada Pacific R. R. It is about as far as the section will ever get, or ought to get.——President Garrett, of the B. & O. R. R. has been buying pictures.——The "very popular" Superintendents of railways, etc., have been receiving New Year's presents of "plate," etc., from the grateful employes of the roads. Very nice for the Supts.——Mr. A. A. Hobart was recently presented with a $1000 silver service by the C. & N. W. R. R. employes, because he was leaving that road to go to the C. B. & Q. The *Railway Age* is querying what Hobart is going to do with the plate, as he is'nt a married man.——Chairs are scarce on the Gilman, Clinton & Springfield R. R., and so the sympathetic employes have been presenting the Superintendent, Auditor, and Master Mechanic, each with one to rest themselves in. Comfortable!——Occasionally we see a notice in the R. R. papers that another railroad man ventures upon matrimony. Rather reckless.

ARCHES;

CONSIDERED GRAPHICALLY.*

The curved lines of arches are very satisfactory to the eye, and there are many times when it is desirable to introduce them in construction. They may furnish, under some circumstances, a very economical way of spanning an opening, and, in other cases, in conspicuous locations, where beauty of design is regarded, where ample room is desired beneath a roof, and for various reasons, they are employed. Stone arches have been built for many centuries; now-a-days, wood, iron and steel are used as additional materials. If the principles which enable one to ascertain the forces which act in all parts of an arched structure are already understood, designs of this type will be more common.

We are aware how much difficulty most persons experience in first attempting to master these principles, for we can recall the trouble the subject gave us when first entering upon its study. Even one who has successfully worked through the mathematical theory as he finds it in the text-books, may sometimes lose sight of the actual meaning of each step in the process, so that there is a certain mystery about the application of the formulæ to a specific example, although one may feel confident that the results are reliable. To many engineers a treatise on the arch, as usually written, is a sealed book.

It is with the desire to do what we can towards shedding some light upon this subject, as well as to give the ability to design an arch to those who are not familiar with the integral calculus, that we have written these pages. So far as we could, we have obtained our quantities by short and easy ways, and, while it has been convenient to arrive at some of the definite data by the use of the higher mathematics, such data have been obtained from the diagrams, and can be verified by the reader by simple means. It is believed that a number of the facts brought out are new.

An arch may be considered to be any structure which, under the action of vertical forces, exerts horizontal or inclined forces against its supports or abutments. Such a definition would include not only the roof of two simple rafters but also the suspension bridge; and we see no objection to so including them. The case of two rafters we need not touch upon, and the suspension bridge does not come within the scope of these pages, except incidentally, and possibly in the stiffened form, but we do desire to give the principles necessary for investigating stone and iron arches of various forms. We hope to show where certain errors and wrong assumptions have been made by some writers, and we trust that the following investigations will prove of interest and value to all engineers, architects and constructors who may desire to use the arch.

In order that all of our readers may understand the steps taken in the analysis, we have thought it best, at the risk sometimes of appearing to dwell too much on well-known points, to lay down carefully a few fundamental principles, and occasionally, later, to go into some detailed explanations, preferring to err, if at all, on the side of fullness. As we propose, however, to make ultimately, some little use of the method which was elaborated in "Graphical Analysis of Roof Trusses," we shall be obliged to refer to that book, or to Vol. III of "ENGINEERING NEWS," for its full illustration.

It has been our aim to put this subject in such a shape that the reader could follow the reasoning intelligently with only a moderate knowledge of the principles of statics, and if, at times, a section occurs which is not clearly understood by such an one, such portions will prove, we believe, not essential to the understanding of the general subject. It will aid the student greatly, if he will draw for himself, from time to time, the various problems, on a much enlarged scale, care only being required to give accurate results. We need not assure those already familiar with graphical statics how comprehensive and flexible such methods of analysis are, and how valuable they even become as a check on mathematical computations.

1. We know, by one of the first theorems of statics, that, if three forces, not parallel, act upon a body and are balanced, their directions must intersect at a common point, and that these forces must be proportional to the sides of a triangle drawn parallel to their directions; and that, conversely, if three forces be assumed as parallel to

Fig. 1.

the three sides of any triangle, and proportional in magnitude to the same sides, with the direction of the several forces taken in the order obtained by passing over the sides of the triangle in succession, these three forces, applied to a structure so that their directions shall pass through a common point, must balance or be in equilibrium.

Entered accordi g to Act of Congress, in the year 1877, by CHAS. E. GREENE, in the office of the Librarian of Congress, at Washington.

If the weight W, Fig. 1, be hung from two points, A and B, by the cords A C and C B, we may find the pull or tension on each of the cords by drawing a vertical line *a b*, equal, by any convenient scale, to the given weight W, and then drawing the lines *a c* and *b c*, from the extremities of *a b*, parallel to A C and B C, and intersecting at *c*. Then will *a c* and *b c* represent, by the same scale by which W was laid off, the pull on the cords A C and B C. The arrows represent the directions of the stresses relatively to the point C, and the arrows on the triangle *a b c* must be found to point successively in order round the triangle.

If W and the two stresses *a c* and *b c* had been given, we might have reversed the problem, and found the direction and length of two chords which, while supporting W, would have exerted the given tensions on the points A and B. It is well to notice that, as it is possible to draw any number of triangles on the line *a b*, we may have a like number of arrangements of cords from A and B to carry W.

2. If we now refer to Fig. 2, and pay no heed for the present to the curved line, we shall see that, when several weights are suspended from the points A and B, by means of a cord A F B, whose weight may be neglected, the tensions on the several portions of the cord may be found by the successive applications of the above process. Thus the weight at G is balanced by the tensions of B G and G I, and we may draw the triangle of forces for the point G. Next, having the weight W_3, and the tension, just found, on G I, we may draw a triangle for the point I, and so on.

But, since each of the triangles will have one side, which represents the weight, vertical, and since one side is common to every two triangles, they may all be combined in one figure by the following construction. Draw a vertical line 2-1, and measure off on it W_3, W_2, etc., successively, by any convenient scale of pounds or tons to the inch. Draw 1-0 parallel to B G, and 2-0 parallel to A K. Connect the point 0 with the other points of division on the vertical line. Then will 1-0, 3-0, 4-0, and 2-0 be equal to the stresses in B G, G I, I K and K A, and the portions of the cord must be parallel to the lines radiating from 0, or the chord will not be in equilibrium.

3. The figure 012 will be called the *stress diagram*, the vertical line the *load line*, and the cord from A to B, which hangs in what is known as a *funicular polygon*, we shall have occasion to disignate, when it is applied to arches, as the *curve of equilibrium*. When the load is continuous this name will seem more appropriate, but it will also, be used as a general term, even in denoting a funicular polygon of but two lines, like Fig. 1. It will be noticed that

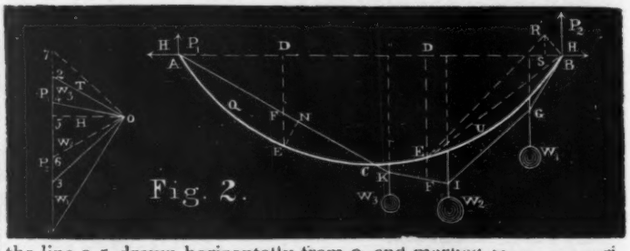


Fig. 2.

the line 0-5, drawn horizontally from 0, and marked H, is the horizontal component of the stress in each portion of the cord, and is constant at all points of a cord under vertical forces or loads only. It will also be seen that we may have any number of funicular polygons between A and B, which shall support the given set of weights at the same distances horizontally from the points of support, the line 1-2 remaining the same, but the point 0 falling at a greater or less distance from the vertical line. H will therefore have a different value for each polygon.

4. Now suppose that a curved rib A C E B, of any material which possesses stiffness, for instance iron, is attached by a pin, on which it can turn freely, to each of the points of support, A, and B, and has suspended from it certain known weights, represented by W_1, W_2, etc., at known points. The weight of the arch itself is not at present considered. The rib, if flexible, as a cord or chain is flexible, will tend to assume the shape of the funicular polygon, or curve of equilibrium, proper to these weights in their respective positions. If we lay off the load line 2-1, to any scale, space off on it the weights in succession, assume any convenient point 0, draw radiating lines from that point to the point of division and to the extremeties of the load line, and then, starting from A, or any other point in the vertical through that point of support, draw lines, successively parallel to the lines radiating from 0, and limited by the verticals through the weights, one such curve of equilibrium will be found.

By moving the point 0 the funicular polygon will strike the vertical drawn through B at a different point, and, if 0 is horizontally opposite the point which divides the load line into the two supporting forces, the polygon, drawn from A as a point of beginning, will strike B. But, even then, 0 may move on a horizontal line, and H will then have any value we please. H is therefore, at present, an unknown quantity; but we will suppose that A E I B is the desired curve of equilibrium for this given case, an imaginary line, the weights being attached to the arch.

RISE AND PROGRESS OF AMERICAN ENGINEERING.*

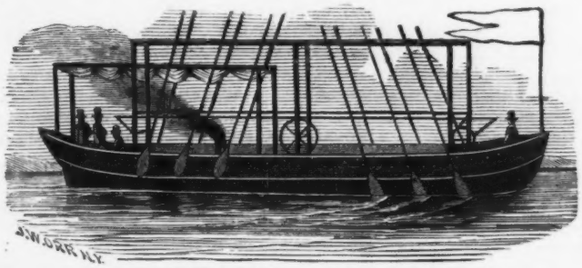
[From the Proceedings of the American Society of Civil Engineers.]

At this Centennial time, when the minds of all are carried back over the past 100 years of unexampled prosperity in the United States, it may not be inappropriate to make a brief retrospect of the progress of engineering in our country since the commencement of its existence, to see what improvement has been made in the profession, and in the size and importance of its works, during the past century.

At the time of the establishment of our present government, very little had been done in the way of public improvement. A few roads had been constructed, such as were suited to the exigencies of the time, and upon them were bridges of rude construction, built as occasion demanded, probably not much unlike the country roads of the present day. They were few and far between, however, and served as the only means of communication from place to place.

Very shortly after the establishment of the general government, the necessity of better means of internal communication became apparent, and considerable attention was given to a better system of roads and canals. Steam, as a means of locomotion was then unknown. Mr. Washington, our first civil engineer, had already given much consideration to the subject of canals, particularly to the connection of Chesapeake Bay with the Ohio river, and made a reconnaissance for that improvement. He also made a report upon an examination of the Ohio river, for which he received the thanks of the Legislature of Virginia.

In 1784, he presided at a commission at Annapolis to consider a project for the improvement of the navigation of the Potomac, which ultimately became a canal to Pittsburg. He was also interested in the Dismal Swamp Canal, connecting Chesapeake Bay with Albemarle Sound. Perhaps the most important work early begun by the general government, was the national road, which extended finally to



THE SECOND EXPERIMENTAL BOAT OF JOHN FITCH.

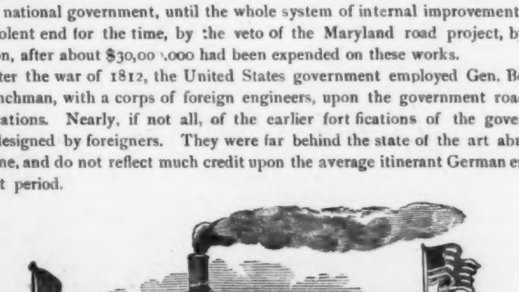
Finished in May, 1797, and run at the rate of four miles per hour on the Delaware. Cylinder 12 inches in diameter, stroke 3 feet.

Cumberland, then through the States of Maryland, Pennsylvania, Virginia, Ohio, Indiana and Illinois, to St. Louis. It was built chiefly by reserving a percentage upon the sales of government land, and was of great value to the States through which it passed, as a means of communication by wagons. A branch turnpike was also constructed from Baltimore to Wheeling. The time of transit from Washington to Wheeling, and from Baltimore to Wheeling, was reduced from eight to three days. Many other roads were projected by Congress, and built under the direction of the War Department.

These national roads were not remarkable pieces of engineering, so far as location and construction were concerned, and involved no extraordinary amount of engineering talent in building them.

Improvements in the navigation of rivers, on a small scale, were also executed by the national government, until the whole system of internal improvements came to a violent end for the time, by the veto of the Maryland road project, by Gen. Jackson, after about $30,000,000 had been expended on these works.

After the war of 1812, the United States government employed Gen. Bernard, a Frenchman, with a corps of foreign engineers, upon the government roads and fortifications. Nearly, if not all, of the earlier fortifications of the government were designed by foreigners. They were far behind the state of the art abroad at the time, and do not reflect much credit upon the average itinerant German engineer of that period.



THE FIRST STEAMBOAT EVER BUILT TO CARRY PASSENGERS.

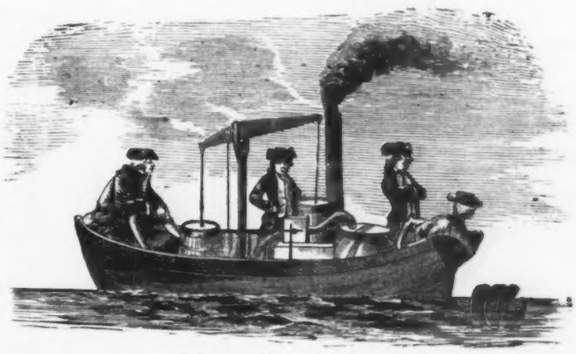
Constructed by John Fitch, and finished April 16th, 1789. Cylinder 18 inches in diameter, speed 8 miles per hour in smooth water. The following year this boat was run to Burlington regularly as a passenger boat.

While the general government was looking after the roads, rivers, harbors and fortifications, the States individually were projecting canals. Pennsylvania, about the year 1788, appointed commissions to examine and report upon routes for connecting the Delaware with the lakes. They reported upon a route by the way of the Juniata, partly by canal, and partly by improving the river. The result was a charter of the Schuylkill & Susquehanna Company, in 1789, and the Delaware & Schuylkill in 1790.

In New York, the Erie Canal had been projected by Governor Morris. In Massachusetts, the Middlesex Canal, from Boston to Lowell, was authorized in 1789, and finished in 1804. In South Carolina, the Santee Canal, 22 miles long, was completed in 1802.

These were but the commencement of the canal systems which were carried out afterwards by several of the States, but the canals already built showed that American engineers were equal to the task that would shortly devolve upon them.

Meanwhile, a slumbering giant, that was to entirely revolutionize the system of transportation, and entirely change the direction of engineering works, was just beginning to awaken to a sense of his power and future ascendancy over the heretofore known methods of locomotion.



THE FIRST PROPELLER EVER BUILT.

Constructed by John Fitch, and experimented with by him on the Collect pond, New York city. The boiler was a 12 gallon pot, with a bit of truck-plank fastened by an iron bar placed transversely. This was in the year 1796.

In 1787, John Fitch, of Connecticut, built, in Philadelphia, the first condensing steam engine in America, with a cylinder of 12 in. in diameter and 3 ft. stroke; and we have every reason to believe that he was at the time ignorant of Watt's experiments in England, which were not made public until 1786. This engine was placed in a steamboat, which was finished in May, 1787, and run at the rate of 4 miles per hour on the Delaware. It was moved by paddles, six on each side of the boat, moving them at one time.

In 1796, the first propeller ever built was constructed by John Fitch, and experimented upon by him on the Collect Pond in New York city.

On April 16th, 1798, he finished the first steamboat ever constructed to carry passengers. The cylinder was 18 inches diameter, and the speed was 8 miles per hour. The following year, 1799, this boat was run regularly on the Delaware river from Philadelphia to Burlington, as a passenger conveyance.

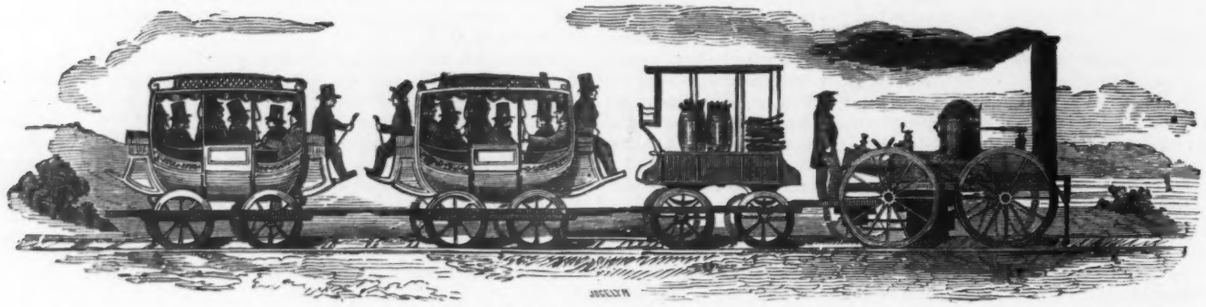
John Fitch saw the value and importance of his invention, and has put it on record in these words: "This will be the mode of crossing the Atlantic in time, whether I shall bring it to perfection or not; steamboats will be preferred to all other conveyances, and they will be particularly useful in the navigation of the Ohio and Mississippi. The day will come when some more potent man will get fame and riches for my invention."

In 1804, Oliver Evans constructed for the Board of Health, Philadelphia, a machine for cleaning docks, which he called the Orukter Amphibolos, or Amphibious Digger. It consisted of a heavy, flat-bottomed boat, 30 ft. long and 12 ft. wide with a chain of buckets to bring up the mud, and hooks to clear away sticks, stones, or other obstacles. It also had wheels for running on the land, and a stern wheel for propulsion when afloat. It was operated by a high-pressure engine, the cylinder of which was 5 in. diameter and 19 in. stroke. The whole apparatus weighed 35,500 pounds, and could be run by the engine up any slope of less than four degrees. This seems to have been the archetype of stern-wheel steamboats, dredging-machines and steam carriages.

Evans was not the original inventor of either the high pressure engine or the stern wheel, but he was the first to apply them to practical use for propulsion. The high pressure engine was invented by Trevithic, in England, and the steam wheel was described by Jonathan Hull, also in England, in 1736. Steam was working its way onward, but at the commencement of the present century it had not yet become a motive power for transportation. Stage coaches, even, had not yet come into general use, and traveling was mainly done by means of the water courses and on horseback. What a field this presented to the American engineer, and how it was improved, we shall see.

Many are still living who might have read in a New York paper, the following advertisement: "*Sloop Experiment.—For Passengers only.*—Elias Bunker informs his friends and the public, that he has commenced running a sloop of about 110 tons burthen, between the cities of Hudson and New York, for the purpose of carrying passengers only. The owners of this vessel being desirous of rendering the passage as short, convenient and agreeable as possible, have not only taken care to furnish her with the best beds, bedding, liquors, provisions, etc., but they have been at very great expense and trouble in procuring materials, and building her on the best construction for sailing, and for the accommodation of ladies and gentlemen travelling on business or pleasure. Merchants and others residing in the northern, eastern or western counties, will find a great convenience in being able to calculate

* Address by Vice-President Theodore G. Ellis at the opening of the Eighth Annual Convention of the American Society of Civil Engineers at Philadelphia, June 13th, 1876.



FIRST LOCOMOTIVE EVER RUN ON THE MOHAWK VALLEY RAILROAD.

(at home) the precise time they can sail from Hudson or New York, without being under the necessity of taking their beds and bedding, and those in New York may so calculate their business as to be certain of comfortable accommodation up the river."

This was luxurious travelling for those days, but Capt. Bunker and his sloop was destined to give way to the power of steam.

In 18 7, Fulton launched the "North River of Clermont," the first steamboat on the Hudson. It was 133 ft. long 18 ft. beam, and 8 ft. deep, and of about 160 tons burthen. She had side wheels of about 15 ft. diameter, with a cylinder of 2 ft. diameter and 4 ft. stroke. The engine was 20 horse-power, of Boulton & Watt's construction, built in England in 1805, which Fulton import d for the purpose. This boat made regular trips from New York to Albany, at a speed of 4 miles per hour.

Robert Fulton, a Pennsylvanian, was a professional civil engineer; he was admitted formally in London in 1795; in 1793 he wrote a treatise upon steam navigation, of great merit at the time. In 1803, Fulton tried some unsuccessful experiments upon the Seine. In 1806, he visited the "Charlotte Dundas," a steam tow boat built by Symington in 1803, and used upon the Forth & Clyde canal, and shortly afterwards returned to New York, prepared to introduce a new era in passenger transportation.

In 1811, Fulton & Livingston built at Pittsburg the first steamboat that ever floated upon the western waters. This was the Orleans, a stern wheel boat, with two masts. In the winter of 1812, she made her first trip from Pittsburg to New Orleans in fourteen days. In 1818, the first steamboat was built for the great lakes, at Black Rock, on the Niagara river. This steamer was named the "Walk-in-the-Water;" she was a fine vessel of 360 tons, brig rigged; with a Boulton & Watt engine, built by Robert McQueen, at the corner of Centre and Duane streets, New York city. Her cylinder was 40 in. diameter and 4 ft. stroke.

Vast strides had been made in the construction of steamboats since Fulton's successful introduction of the "North River of Clermont," and they multiplied rapidly upon all our waters.

Meanwhile, the character of the roads was improving, and internal land communication was becoming of more importance. The stage coach was arriving at its palmy days of transient glory, and engineers were called upon to build more extensive bridges for these rapid transit conveyances to cross the streams. Here was a branch in which American engineering early commenced to show great proficiency. The size of our rivers rendered important and substantial works necessary upon all the main thoroughfares of stage travel. The magnificent timber bridges of Wernwag, over the Schuylkill and at Trenton, were constructed early in the present century, and have been a monument to the fame of the great engineer who constructed them. The celebrated bridge of 340 ft. span over the Schuylkill, was built in 1812, and was burned in 1838. Thus engineering progressed until the great days of railway communication opened a new field for American engineers.

It is amusing now to look back to the period just previous to the introduction of the locomotive engine, and see how the older members of the profession now living, and probably some present, traveled to their conventions, if they had any. At the commencement of the present century, conveyances between New York and Philadelphia were advertised in the Philadelphia papers, as follows:

"*Philadelphia Stage-Waggon and New York Stage-Boat performs* their *stages* twice a week. John Butler with his waggon sets out on Monday from his house, at the sign of the Death of the Fox, in Strawberry Ally, and drives the same day to Trenton Ferry, where Francis Holman meets him, and proceeds on Tuesday to Brunswick, and the passengers and goods being shifted into the waggon of Isaac Fitzrandolph's the same day, when Reuben Fitzrandolph, with a boat well suited, will receive them and take them to New York that night. John Butler returning to Philadelphia on Tuesday, with the passengers and goods delivered to him by Francis Holman, and will again set out for Trenton Ferry on Thursday; and Francis Holman will carry his passengers and goods with the same expedition as above to New York."

Somewhat later an entirely land route was adopted, as set forth in this New York advertisement: "*For Philadelphia and Baltimore—Swiftsure Mail Stage.* A new line has been removed from No. 2 Cortland to No. 116 Broadway, and is now running between New York and Philadelphia, through a beautiful country, on the short and pleasant road through Newark, Springfield, Scotch Plains, Bound Brook, Somerset, Arnwell, Coryell's Ferry, Cross Road Crooket Billet, and Jenkintown to Philadelphia.

"To start from New York every day at 10 o'clock A. M. (Sundays excepted), lodge at Somerset, and arrive at Philadelphia the next day afternoon. The Swiftsure is the only opposition stage from this city to Philadelphia and Baltimore."

A few years more brought steamboats into competition with the mail coaches, and the number of travellers became greater, so that at that semi-centennial jubilee held in Philadelphia on July 4, 1825, it was recorded in the Philadelphia Gazette, that 300 New Yorkers were said to have been in Philadelphia. There were a sufficient number of passengers to fill twenty-five coaches. Fifty years have passed on, and what would Francis Holman, John Butler and Reuben Fitzrandolph, with "his boat well suited," or thirty-five stage coaches have done with the crowd that is here to-day?

The advent of steamboats gave an impetus to engineering works of greater magnitude than before. On July 4th. 1817, the Erie Canal was commenced, and was finished in 1825. In 1819, the first steam-boat that ever crossed the Atlantic, sailed from Savannah to Liverpool. In 1823, the Erie and Lake Champlain Canal, 63 miles long, was finished, and about this time many canals were commenced, some of which were not opened until after railroads had made considerable progress. In 1825, work was commenced on a canal, 307 miles long, to join the Ohio river at Portsmouth, Ohio, with Lake Erie. This was finished in 1833. In 1826, the canal, and afterwards partly railway route, through Pennsylvania was commenced, and this was finished in 1834, 395 miles to Pittsburg. In 1828, the Cumberland route was commenced, and finished in 1840.

Events were progressing rapidly in American engineering about those days; canals and roads had been built, and were building and extending over the country. Steamboats had multiplied, as if by magic, upon all our lakes and rivers, and the excitement regarding internal communications was at its height, when news came across the ocean of the success of the Darlington Railway, which actually carried passengers at the astounding rate of seven miles an hour.

America was ripe for the improvement. A short railroad, the first in the country, had been opened in 1826, from Quincy to Milton, 2 miles, and the next year was continued to Neponset, 3 miles, for the transportation of stone. The celebrated Mauch Chunk Railroad in Pennsylvania, was commenced, and was opened in 1827. Both of these roads were "horse railroads."

In 1828, 12 miles of the Baltimore & Ohio Railroad were completed, being the first passenger road in the country. This was two years before the celebrated Liverpool & Manchester Railway was opened, so that we see that American Engineers were not behind the times. In this same year a survey for a railroad was made in South Carolina, and the Western Railroad in Massachusetts was projected.

The second passenger road opened was from Albany to Schenectady, on the Mohawk and Hudson. This was in 1831. The next road finished in the United States was from Richmond to Chesterfield in Va., in 1831, and the same year the road from New Orleans to Lake Pontchartrain was completed.

The reports from the Liverpool & Manchester Railroad gave a great impetus to railways in America, and they were projected in all parts of the country.

The state of the knowledge of such works at that time may be seen by the following extract from "Wood on Railroads" in 1825: "Nothing can do more harm to the adoption of railroads than the promulgation of such nonsense as that we shall see locomotive engines travelling at the rate of 12 miles an hour."

The first locomotive engine run upon a railroad in the United States was the "Lion," imported in 1829, by Horatio Allen, for the Delaware & Hudson Canal Co. It was first started by Mr. Allen himself, upon the banks of the Lackawaxen, and he has graphically described it in some of his published remarks. This engine was built by Messrs. Foster, Rastrick & Co., of Stourbridge, England. Another engine, built by George Stephenson, is reported to have been imported a short time before the "Lion," exhibited in New York, and run with the wheels raised from the ground. I do not know what road this engine was intended for.

The first engine built in this country was in the summer of 1830, for the South Carolina R. R., by the West Point Foundry Co., at their shop on West street, New York city. It was called the "Best Friend," and had four wheels and an upright boiler. This engine blew up shortly after it commenced running, and was rebuilt with a horizontal boiler. The second locomotive built in the country was the "West Point," likewise for the South Carolina railroad.

In 1831, the "De Witt Clinton" was built by the same company for the Mohawk & Hudson Railroad. This engine weighed four tons, and could run 40 miles an hour. It had cylinders 5½ in. diameter, and 16 in. stroke, with 4 coupled wheels 4½ ft. in diameter.

Concluded next week.

THE ASHTABULA BRIDGE.

With the progress of the coroner's inquest at Ashtabula, some points which bear upon the cause of the disaster come to light. Judging from the reports of the testimony there seems to be no strong evidence that the train was thrown from the track previous to the giving way of the bridge; indeed the impressions of a few of the passengers at the first shock that the wheels were off the rails is naturally the idea that would flash through the brain at such a crisis.

It was previously stated that this bridge was a Howe truss, built in iron, and carrying two tracks on the upper chord; it had a span of about 156 feet, was twenty feet deep between centres, and had twelve panels. It was built about eleven or twelve years ago, to replace a wooden structure of some 300 feet in length, the remaining space, at each end of the truss, being occupied by a stone arch, and an embankment. It contained improvements made and patented by Mr. Amasa Stone, then president of the road, was said to be designed by Mr. Joseph Tomlinson, and was constructed in the company's shops at Cleveland. The responsibility lies, therefore, with the railroad company entirely, if the structure was weak and is shared by no outside firm of bridge builders.

The officials now connected with the road do not testify that they have ever had any suspicions in regard to the strength of this bridge, and they appear to have no theory to offer for the occurrence of the accident. Mr. Geo. M. Reid, the superintendent of bridges for the entire length of the Lake Shore Railroad, testifies that he has been in the employ of the road three years; that previous to that time, he was employed by the McNairy & Claflin Manufacturing company of Cleveland; that he is perfectly familiar with the construction of iron and wooden bridges; that he considered himself perfectly familiar with the Ashtabula bridge, thought it a very strong bridge, heavy in all its parts; had never received any report that there was anything serious the matter with it, and it never needed anything but trifling repairs. He went through the bridge last September for inspection, examined it for two hours, and while so doing, two trains passed over. He says that he has made bridges a study for twenty-five years; that this one was put up in 1865, was considered above the ordinary run of bridges; that he doesn't know there was any objectionable feature, and that he had every confidence in the bridge. Mr. A. S. Rogers, in charge of all the carpenter work between Cleveland and Erie, corroborated Mr. Reid's testimony, and considered the bridge perfectly safe.

So much for the company's employees. The testimony of Mr. Joseph Tomlinson has somewhat of a different complexion. He testifies that h is now general superintendent of light-houses in the employ of the Canadian Government, and resides at Ottawa, Canada; that he was engaged in bridge building from 1840 to 1870, and made the drawings for this bridge. He did this under instructions from Mr. Stone. He never approved of a wrought iron Howe truss over a large span, as it makes an unnecessarily heavy bridge, and all the strains accumulate on the end braces. Notwithstanding its weight, it would have been a strong and durable bridge had the main braces been sufficiently strong. They were not made as large as originally designed, and it was his intention that they should be strengthened, but his connection with the company was severed on account of a difference that arose between himself and Mr. Stone concerning this bridge. He thought that the main braces were the only defective parts of the bridge. This was the only defect that he was aware of, except its unnecessary weight. He thinks it would have been an exceedingly strong structure had it not been for these defects. Mr. Collins (the present engineer) had nothing to do in any way with the bridge to his knowledge. The bridge was calculated to carry a moving load of two to three tons to the lineal foot. He was dictated to, in making his plans for the bridge, by Mr. Stone. If the iron had all been good, and wrought according to the patterns, and placed in their proper positions, he thinks the bridge would have been perfectly safe. In the original plan made by Mr. Tomlinson the braces were calculated to bear a pressure of four tons to the square inch. He was informed what alterations had been made in remodeling the bridge. He thinks that a pressure of four tons to the square inch on these braces would have caused lateral deflection. He proposed a method of strengthening the defective braces to Mr. Stone, to which Mr. S. would not listen, and even became angry. It was in consequence of this difficulty that he resigned his situation. Mr. Tomlinson never had any anxiety about the braces. He doesn't think a better set of rods or chords were ever put into a bridge.

We have, further, seen a published letter from Wm. T. Daly, traveling agent of the Toledo, Smith bridge company, to his employers. After giving the span and height of the truss, he states the following facts as the results of his own examination. "The top chord is made of five 6-inch I beams, varying from light 6-inch to extra heavy, with a web ⅞ inch thick. The braces are made of three pairs of 6-inch beams at ends, and three single ones at the centers; counter of two 6-inch beams. There are no beams over six inches in the bridge. The rods are eight, at each panel, varying from 1½ inch to 2⅛ inch rods. I saw five breaks in the top chord and braces, and about 26 breaks in the rods, and from the look of all the fractures there is no doubt with me as to what caused the bridge to give out. There are not any of the rods or top chord pieces or braces which have any fibre at all. It is almost as brittle as cast-iron. The lower chords at the ends are five in number, 1⅜ by 5 inches, laid horizontally, and, as there was no break in them, I could not judge of the quality."

As the bottom chord is entire, the fault must have been in some other portion of the bridge. The impressions of the last person cited above, as to the quality of the iron, there should be no difficulty in verifying. It looks as if a poor article was employed, and the depth of six inches is a small one for main braces some twenty-three feet long, even if supported by a counter at the middle of the length. The top chord too, apparently has no more depth. The design of the bridge should be thoroughly overhauled, and the quality of the material used should be tested. We hear that the railroad company are inclined to deny all claims for damages, for loss of life or injury, on the ground that the accident was caused by circumstances beyond their control, the storm and cold weather, rendering the iron weak. Such a defence will necessitate a careful examination of the wreck by competent persons, even if such an inspection was not resolved on before. Suppose that parties should erect a structure of "cold-short" iron, and, when it fell on some cold day, should claim that it was no fault of theirs. If the iron was poor the company cannot waive the responsibility for a bridge built in their own shops, by their own men. If the design was faulty, they are equally bound by the acts of their agents.

Would not this be a good time for the *Society of Civil Engineers* to bring up again, and press through to consummation the plan for a committee of engineers to examine and approve of every structure of this kind before it is open to public use. A careful inspection of existing bridges, and a criticism of plans for new ones, with proper tests after erection, will give the traveling public that assurance of safety which they do not now possess. It is fitting for the American Society to move in this matter, as they are the professional body who would have the most weight, and they are personally interested in the good repute of the profession and its proper elevation. As it is at present, there is scarcely any hindrance to parties building any structure they see fit, except the fear of pecuniary damages from an accident, of loss of business reputation as a reliable company, or as a question of dollars and cents in present outlay and future renewals. The inspection by railroad commissioners in some states amounts to something, but is not altogether satisfactory. There are many cases also, where railroads have been pushed to completion with scanty means, and temporary structures have been erected, to be replaced later; but lack of means and hard times necessitate a postponement of such improvements and a patching and *making do* which are hazardous to the public safety. As prevention is better than cure, we ought to be protected by better legal enactments and early inspection and oversight of all details on which safety depends, rather than to run the risk of life or limb, and then have the parties on whom responsibility can be fixed mulcted for damages. The public attention is so thoroughly awakened on this subject, that now is the time to act, and get proper measures passed.

THE full-sized details of top and bottom chord connections for the iron and the wooden bridges manufactured by Kellogg and Maurice, Athens, Pa., and exhibited by them at the Centennial Exhibition, with complete working drawings and strain sheets of both bridges, have been purchased by the University of Michigan for the Civil Engineering department. These models show a short section of top and bottom chords, with the eye-bars, pins, lateral bracing, floor-bearing, etc., of full size, but with the post shortened to some four feet in height.

AT a meeting in Detroit, last Saturday, of gentlemen interested in the tunnel project, the mayor and one of the aldermen were authorized to appoint a committee of experts to receive propositions from Gen. Wm. Sooy Smith and others, to report at a future meeting, and in the meantime Mr. Luther Beecher will take the initiatory steps for the formation of a tunnel company. Mr. Beecher said that the estimated cost of the tunnel proposed by Gen. Smith is $1,500,000, and, to give the project an impetus, he would guarantee to raise $500,000 of the amount, if the citizens would raise the balance.

THE Committee appointed by the Mayor and Mr. Chesbrough, the City Engineer, for the purpose of testing the West side Water Works of the city of Chicago, have been engaged on that important work during the present week. The following gentlemen form the committee: Chas. Hermany, C. E., Louisville; Moses Lane, C. E., Milwaukee; Thos. J. Whitney, C. E., St. Louis; Chas. H. Haswell, C. E., New York city; Henry Warrington, C. E., Chicago. The Quintard Iron Works Co., makers of the huge engines and machinery, a mass of between 700 and 800 tons weight, is represented by Messrs. Wilson and Sankey, and the attorney, Mr. F. Tuley.

The testing process being now in progress, we postpone a fuller account until our next issue.

CONDITIONS OF SAFETY IN PUBLIC BUILDINGS.

BY JAMES R. WILLETT, ARCHITECT.

The awful calamity in Brooklyn has stirred up the people everywhere. It was known to those who had given attention to the subject that theatres and public halls generally were deficient in many respects; but the burning of the Brooklyn theatre, together with nearly three hundred persons, has caused investigations to be made into the conditions of buildings intended to contain public assemblies throughout the country.

The principal conditions of safety to the audience in such buildings are as follows:

The building should be of ample strength in all its parts.

There should be separate, distinct exits of ample size, in each of the four corners of an auditorium, not only from main floor but also from each gallery, if there be any; these exits, and all stairs, etc., leading thereto, should be kept as far distant from other stairs and leading from the same floor, as is practicable.

There should also be a separate and distinct exit for every three hundred people in the building, and no door, stairs, passage, etc., should be less than five feet wide; if those at the four corners do not comply with this condition, then additional ones should be made.

Hand rails should be placed on both sides of all stairs, passages, etc.

Stairs should not be long and straight; they should have many landings and should alter their direction at each landing, but no winding steps should be put in. It is equally true that there should be no long straight halls.

The buildings should be entirely detached from others. If this is impossible then it should only adjoin another building on the side of stage or platform.

The main floor should not be more than a few feet above the grade of streets.

It is a mistake to suppose that a frightened crowd of people will get out of a building as rapidly as one which is not frightened; quite the contrary is the fact. When frightened, people press, crowd and overthrow one another until their fallen bodies form a barrier which prevents any egress whatever, it is perfectly idle to expect people to keep cool; some cannot do so, and when they struggle others will do the same.

It is, of course, impossible to make any building so

that an accident will never occur in it; but it is possible to make it so that a panic-stricken crowd cannot seriously injure many of themselves. The way to do this is by having numerous, separate, distinct and ample exits, and no building should be licensed unless it has them.

There are of course many other requirements that should be satisfied that we cannot state, but if the few we have named are observed there will be no repetition of any such great calamities happening in the future.

PRAIRIE CREEK BRIDGING.

While eminent civil engineers are designing strong, expensive structures to span the broad rivers and deep gorges of the world, either by solid stone arches, suspension, truss, or tubular bridges, there are multitudes of small streams to be bridged in a cheap, simple and substantial way.

Many of the creeks in the prairie states, in summer and early autumn, are dry, or nearly so; while in the spring they overflow their low banks and inundate a large extent of territory, necessitating long, low structures.

The common creek bridge is a framework in bents, each one having its mud sill buried in the soil or soft bottom of the water course. We think we have a better plan than the above. All our bridges, some of them three hundred feet in length, are on piling, set in rows crosswise of the road bed, and the rows far enough apart to make spans of the required length for the floor joist to be used. On each cross row of piling a cap is framed; upon these the bridge proper is constructed. If it is necessary that a wider span should be erected over the channel, a simple truss is used. Structures of this kind stand the ice, driftwood, and high waters, better than those on mud sills, and can be repaired more easily. But, says the thinking reader, "to build such structures a pile driver is required" which is expensive, unwieldy, slow in its operations even in the hands of experienced men, and to construct a few bridges the expense would be too great. This is all true. We did use one of these weighty machines for a few years,—till one of our practical farmers discovered a cheaper, more rapid, and a better way of doing the pile driving. All this work is now done with a twelve-inch post auger. This simple instrument in the hands of an experienced artesian well borer (of which there are a number in this county who have sunk hundreds of flowing wells) is used to sink a circular shaft the necessary depths, into which the p le is placed large end down, and sand filled in to hold it fast. In this way the work is accomplished with tools that can be moved from place to place with a pair of horses, and erected and worked by two men.

At places where there is but little travel, and a long high-water bridge too expensive to be constructed, we make low-water bridges in the way mentioned, fastening the roadway to the piling by strong iron bolts. These low water structures are inclined towards the water up stream, so the rising floods will flow on to the planking and tend to load it, rather than flow under and lift it.

What do you think of our way of setting piles and bridging in the prairie land? M. H. MESSER

ONARGA, ILL.

ANNUAL REPORT OF THE BOARD OF DIRECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, FOR THE YEAR 1875-6.—*Accepted Nov. 1st, 1876.*

The membership is:—

Honorary members, resident, 2; non-resident, 4; Corresponding members, non-resident, 3; Members, resident, 113, non-resident, 304; Associates, resident, 5, non-resident, 11; Juniors, resident, 7, non-resident, 44; Total, 484. Fellows, 70—of whom 10 are members and 1 Hon'y member—leaving 59. Total now connected with the Society, 552. On November 3d last, the number of proposals and applicants for admission to the Society was 23; the number of proposals and applicants during the year was 70; total number of proposals 93.

Of this number 2 were elected as Corresponding members, 50 as Members, 20 as Juniors and 2 as Fellows; 4 were laid on the table or withdrawn, and 6 are pending.

Of those who were elected, 1 Junior was proposed as Member; 4 Members elected before November 3d last, and 2 Corresponding Members, 40 Members, 18 Juniors, and 1 Fellow elected during the year, have qualified.

The increase during the year has been:

Corresponding Members, 2; Members admitted, 44—2 Associates and 2 Juniors became members, 48—less 1 deceased and 1 resigned, 46; Juniors, 18—less 2 became Members and 1 deceased, 15. Deduct—2 Associates who became Members, 2 Fellows deceased, less 1 admitted; Total increase, 60.

Twenty-one meetings of the Society were held during the year, one of which was the Eighth Annual Convention, and one—a stated meeting—held as an "officers' reception;" 10 were "regular" meetings, at which ballots for members were canvassed and other business done, and 9 were "stated" meetings, when papers were read and discussions had upon engineering subjects and generally time given for conversation.

Eleven stated and 3 special meetings of the Board were held during the year, generally for examination into the qualifications of candidates for membership, the application of the Society's funds, and similar general business of the association.

The Eighth Annual Convention was held in Philadelphia, June 13th, 14th, and 15th, accompanied by brief excursions to a few points of interest in the city, and a trip over the "New York & Philadelphia New Line" to New York and return.

Papers were presented to the Society during the year as follows:

Description and Results of Hydraulic Experiments with large Apertures, at Holyoke, Massachusetts, in 1874; Theodore G. Ellis. Efficiency of Steam Vacuum Pumps; J. Foster Flag. Note on the Resistance of Materials; Robert H. Thurston. Verrugas Bridge and the Method of its Erection; L. Lefferts Buck. The Portage Bridge; George S. Morison. The Practical Determination of Strains in the braced Arch; A. J. DuBois. Discharge of Water in Jets and Long Mains; Galen W. Pearsons. Notes and Suggestions on the Croton Water Works and Supply for the Future; Benjamin S. Church. Theory of Continuous Girders in Relation to Economy in Bridge Building; Charles Bender. Note on the Resistance of Materials, as affected by Flow and by Rapidity of Distortion; Robert H. Thurston. Fac Simile Telegraphy; Robert L. Cooke. A Water Conduit under Pressure; John T. Fanning. History of the Lehigh Coal and Navigation Co. and its Works; Robert L. Cooke. Determination of the Resistance of Railway Trains; Robert H. Thurston. Reconstruction and Enlargement of Cork River Tunnel; Max. J. Becker. Memoirs of American Engineering; John B. Jervis. Dams for Reservoirs—Shall they be of Earth or Masonry? William J. McAlpine. Connected Segmental Marine Boilers, a Demonstration of the Principles of their Construction; Charles E. Emery. Railroad Accounts and Returns; William P. Shinn. Qualities of Iron and Steel; William Metcalf. A Cheap Transfer Table; William P. Shinn. Gauging of Streams, a Special Case; David M. Greene. Cut-offs on the Mississippi River, their Effects on the Channel, above and below; Caleb G. Forshey. Laying Masonry in Cold Weather; J. Dutton Steele. Compressed Air Locomotives; J. Dutton Steele. Principles of Tidal Harbor Improvements, as applied at Wilmington, Cal.; Clinton B. Sears.

Reports were made to the Secretary during the same time, as follows:

Annual Report of the Board of Direction, on the Affairs of the Society, for Year ending November 3d, 1876. Award of the Norman Medal; Julius W. Adams, Chairman. On Tests of American Iron and Steel (2 reports); W. Sooy Smith, Chairman. On Change of the Society's Rooms (2 reports); John Bogart, Chairman. On Time and Place of the Eighth Annual Convention; G. Leverich, Chairman. On Organization of a Mutual Benefit Society; William E. Worthen, Chairman. On Policy of the Society; Alexander L. Holley, Chairman. On Securing a National Recognition of the Society; W. Milnor Roberts (for Committee). On Uniform Gauging of Streams in Connection with Observations of Rainfall; and On Failure of Dam at Worcester, Mass.; Theodore G. Ellis, Chairman. On Form Weight, Life and Manufacture of Rails; Ashbel Welch, Chairman. On Nomenclature and Classification of Masonry; J. James R. Croes, Chairman. On Resistance of Railway Trains; William P. Shinn, Chairman. On Technical Education; Henry R. Worthington, Chairman.

Discussions were had on many of these papers and reports when read before the Society; also on the following subjects:

Consumption and Waste of Water; Design and Erection of the Exposition Buildings; Docks and Wharves; Engineering Questions considered in the Location and Construction of the New York & Erie Railroad; Improvement of the Mouths of the Mississippi; Levees as a System of Reclaiming Low Lands; Metric System of Weights and Measures; Overland Telegraph to Europe; Professional Intercommunication; Progress of the Jetties at South Pass of the Mississippi; Waves of Translation that Emanate from a Submerged Orifice.

Many of these papers, reports, and discussions have been published in the Journal for the current year; also these papers presented last year:

Notes on the Improvement of the Mouth of the Mississippi; W. Milnor Roberts. Levees as a System of Reclaiming Low Lands; George W. R. Bayley.

Referring to the list of papers presented to the Society which were unpublished at the date of last report; of these, the following were published during the past year:

Experiments on the Tensile Strength of Steel Wire; Thomas C. Clarke. Levees as a System of Reclaiming Low Lands; George W. R. Bayley.

The following was omitted from the list:

Construction of a River Wall at Foot of Canal street, N. R.; William A. Radenhurst and John D. Van Buren, Jr., June 10th, 1875.

And the following presented and not published during this year are to be added:

Efficiency of Steam Vacuum Pumps; J. Foster Flagg, November 3, 1875. The Practical Determination of Strains in the Braced Arch; A. J. DuBois, November 30, 1875. Memoirs of American Engineering; John B. Jervis, February 1, 876. Fac-Simile Telegraphy; Robert L. Cooke, March 27, 1876. A Water Conduit under Pressure; John T. Fanning, April 5, 1876. Reconstruction and Enlargement of Cork River Tunnel; Max. J. Becker, April 15, 1876. History of the Lehigh Coal and Navigation Co. and its Works; Robert L. Cooke, April 19, 1876. Connected Segmental Marine Boilers, a Demonstration of the Principles of their Construction; Chas. E Emery, May 17, 1876. A Cheap Transfer Table; William P. Shinn. June 5, 1876. Principles of Tidal Harbor Improvement, as applied at Wilmington, Cal.; Clinton B. Sears, July 27, 1876.

In addition to these are several reports of Committees, upon a number of subjects, which still are unpublished.

During the year the Journal of the Society has been published monthly at a cost, for 1,000 copies each month, substantially as follows:

For printing, $2,512.05; Illustrating, $393.25; Copyright, $6.00; Total gross cost for 732 pages, $2,911.30. Deduct for 76 pages advertisements, $712.33; Net cost for 656 pages, $2,198.97; or $3.35 per page.

The "Proceedings" contain in addition to the reports mentioned—

Announcements of Meetings to be held; Topics discussed, etc.; Book Notes; List of Additions to Library and Museum; Lists of Members, with Addresses, Changes and Corrections; List of new Engineering and Technological Books; Memoirs of Deceased Members; Notes and Memoranda. Short articles on—American Bridge Construction; American Engineering at the Centennial; Bridges and Bridge Foundations; Centennial Commission of the Society; Committee Work; Compressed Air Locomotive; Concerning Conventions; Dams for Reservoirs; Determination of the Resistances of Railroad Trains; Discharge of Water from Jets and in Long Mains; Fall of an Iron Bridge; Jetties at South Pass of the Mississippi River; Laying Masonry in Cold Weather; Metric System of Weights and Measures; Selecting Papers to be Published; Sketches of Engineering Exhibits at the International Exposition; Tests of American Iron and Steel; Proceedings of the Board of Direction and of the Society; Statement of the Finances of the Society.

A List of Members of the Society, with their addresses was issued May 20th.

CORRESPONDENCE.

ASTORIA, LONG ISLAND CITY, N. Y., *Jan. 10th*, 1877.

EDITOR ENGINEERING NEWS:

SIR:—We were much interested in the article in your paper concerning surveyors, but should suppose from its general tone that you were more specially addressing land surveyors. If your criticisms refer to city surveyors they are certainly wide of the mark. We are sure that your paper has only to be known by the profession to be highly appreciated by every branch, and as you request communications from your subscribers we will be happy from time to time to furnish you with accounts of work being done and the methods and practice of city surveying as carried on in our section. Our office has been engaged for some years in laying out the city, and our work has embraced every variety of city practice, preliminary and detail topography, location of monuments, laying out of streets, avenues, etc., and a complete design for a system of sewerage, portions of which are now building. From actual practice we can send you information interesting to our friends in the west, and will, if you wish it, send on some illustrations for the photo-lithographer.

F. P. THOMPSON and
D. L. TAUNTON
City Surveyors.

EDITOR ENGINEERING NEWS:

SIR:—Permit me to state the following problem in the hope that some of your readers skilled in hydraulics can give me on answer:

Certain parties desiring to obtain water for steam purposes from a river some 750 feet distant, laid a two inch iron pipe from the boiler house and attached a small steam pump, which had previously lifted water from a well nearly if not quite thirty feet vertically. The pump was about 25 feet above the water in the river. The precaution was taken to fill the pipe with water, and the pump was then started. After it had drawn a large portion of the water from the pipe, it failed to get any more. As our informant stated it, "after pumping all the water from the pipe, none would follow from the river." Supposing that the pipe was not accidentally stopped at the lower end, a point which was probably attended to, why would not the pump fetch water.

The explanation which seemed satisfactory to the persons concerned, was that the friction was too great for the power of the pump, and they have since put up a windmill at a lower level. I fail to see how there can be any fluid friction before the water is set in motion, and as the friction is dependent upon the velocity, ought not the pump to draw water at some speed? X.

RISE AND PROGRESS OF AMERICAN ENGINEERING.*

[From the Proceedings of the American Society of Civil Engineers.]

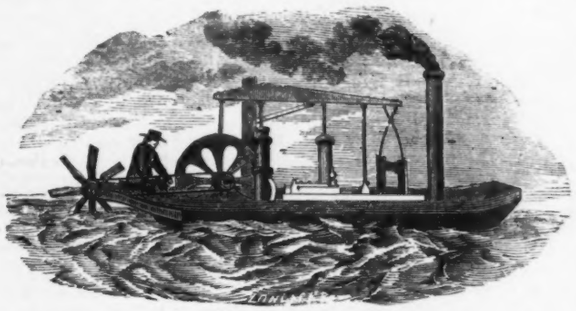
(*Concluded from page 18.*)

Locomotives soon came into general use. Baldwin commenced building them in 1833, and Morris soon after. Then came the Lowell shops in 1835, Rogers, Ketchem & Grosvenor, of New Jersey, in 1837. Then Winans, Mason, Hinckly & Drury, and the Taunton, South Boston, Manchester, Montreal, Lawrence, East Bridgewater, and numerous other works; all of which were busily occupied in furnishing engines for our rapidly extending railroad system.

The Harris engines were the first exported, and since then, locomotives have been sent in large numbers to England, Russia, France, Germany, Egypt and South America.

The railway system opened a new field for engineering, in the substantial structures required for bridges and viaducts, which everywhere were erected, too numerous even to mention here.

Timber bridges were generally erected, and the Burr, Long, lattice, Pratt and Howe trusses, have become identified with American engineering. The Howe bridge is perhaps the most remarkable system of framing, for strength and simplicity, that was ever designed for general use in bridges of all spans.



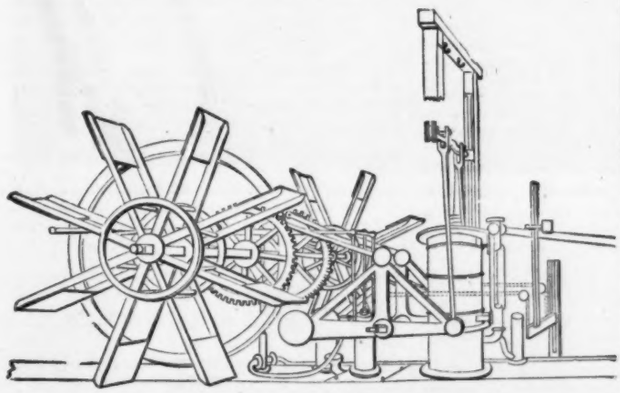
OLIVER EVANS' ORUKTER AMPHIBOLOS.

30 feet long and 12 broad. Cylinder 5 inches in diameter with a 19-inch stroke. Constructed by Oliver Evans about the year 1804.

The first iron railroad bridges were three spans, of about 55 feet each, erected on the Baltimore & Susquehanna Railroad, by James Mulholland, in 1846. These were plate girders. Iron suspension bridges had been previously used. The first in the country was erected by Mr. Finlay, over Jacob's Creek, in Pennsylvania, in 1796, and during the next 25 years about forty had been built on the same plan in different parts of the country.

A cast iron arch of 80 feet span had also been built over the Potomac Aqueduct by Maj. Delafield, in 1840.

Iron bridges, however, did not come into general use until a short time previous to the late war of the rebellion, when several roads, particularly the Pennsylvania, New York Central and New Haven, Hartford & Springfield, commenced replacing their worn-out wooden bridges with iron and stone.



THE MACHINERY OF FULTON'S FIRST STEAMBOAT.

Imported from England where it was constructed in 1805. Wheels 15 feet in diameter, cylinder 24 inches in diameter, 4 feet stroke.

The vast field opened to engineers by the building of railroads, and the incidental works, caused a great addition in numbers to the ranks of the profession, and engineering schools were opened in all sections of the country, which have graduated young men with excellent preliminary training for the profession, and have raised the standard of education for entering the practice of engineering far above what it was half a century ago. At the time of the height of the railway fever, every young man who shouldered a brass instrument was an "engineer." The spirit of the times now requires that he shall know how to use it.

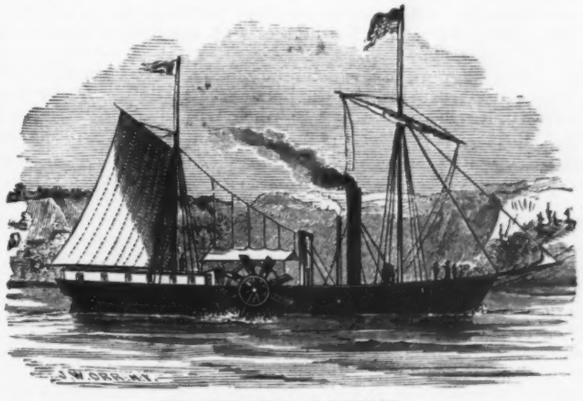
The railroad age culminated with the wonderful achievement of constructing a road through the uninhabited prairies and mountains to the Pacific ocean; a great part of it at the rate of a mile a day. To a European, it is something astounding that in a country just a century old, you can start from New York and ride 3,000 miles westward by railway, without changing cars; living, sleeping and eating on the train, and this chiefly through a country that half a century ago was almost wholly unexplored. Middle-aged men can remember when the Rocky Mountains were as much a "terra incognita" as the interior of Africa now is.

The railway system built up cities, and with their increase came water-works, pumping engines, systems of drainage and gas works, that in magnitude and in constructive excellence eclipse many of those of the old world. The number and magnitude of them is such as to preclude the possibility of naming them at this time. These works are so recent that they are known to us all, and their description fills our current engineering literature. The latest works of American engineers, such as the St. Louis bridge, over the Mississippi, the East river bridge at New York, and many others of less magnitude, but equal merit, the Pacific Railroad, the Hoosac and Chicago lake tunnels, and many other recent constructions, are works of which we may well be proud, as monuments of American engineering skill. Among the more remarkable works of American engineering may also be mentioned the military exploits of civil engineers attached to the army during the late war; the wonderful railway bridges built in a few days at Potomac Creek and elsewhere; the release of the fleet at the Red river; the canal at "Island No. 10, and the Petersburg mine.

In the short space of a century American engineering has risen to the highest standard, and ranks with that of any nation in the world. We have the longest railways, the best equipment and the most comfortable conveyances. We have by far the finest passenger steamboats in the world. We have the largest bridges, the greatest spans, and the deepest foundations, and the only successful railway suspension bridge in the world.

The question remaining to be solved is, what are we coming to? When will our improvements end? Can it be possible that a century from this time the American engineer can look back to such a record of progress as now appears to us? I reply, it is not only possible but probable.

In the age of wood and stone implements, who could have seen the progress of the age of bronze? In the age of bronze, when the pyramids were built, and vast works of years were undertaken, who could forsee the age of iron, with its great architectural and mechanical works? And who could have forseen the wonderful revolution upon the face of the earth that steam should produce?



THE NORTH RIVER, OF CLERMONT.

Robert Fulton's first steamboat as she appeared after being lengthened in 1808. She was launched in 1807, and was run as a regular packet between New York and Albany. Speed 4 miles per hour, length 133 feet, beam 18 feet, depth 8 feet, tonnage 160.

At the present time I sincerely believe that the days of iron and steam are numbered. What the next great improvement will be, we cannot now know; but the signs of the times point to solar heat as the motor that will drive steam from its stronghold, and aluminum as the metal that is to replace iron. The day will soon come when men will smile at iron bridges, engines and tools. Aluminum is the most abundant and best distributed metal on the earth. Every clay bank is a mine. Ways are already known how to reduce it, but with great difficulty and expense; as silicate of alumina, clay is one of the most refractory substances we have to deal with. Let but the discovery be made, how to reduce this metal cheaper, and we might well be astounded with the changes that would occur.

With a metal only 2½ times as heavy as water, 6 times as strong as steel, as easily worked as iron, and almost indestructible in air or water, conceive what would be the possibilities of engineering skill, to say nothing of the revolution in all the tools and utensils of ordinary life. Bridges of a mile span would be entirely possible; railway trains for passengers could be reduced to at least one-fourth their weight, and the navigation of the air (all except the alighting, in which I should never have great confidence), would become practicable. With a motive power which would not be obliged to carry so great weight of fuel as our present steam engines require, speed of navigation might easily be doubled. But these are merely visions in which a practical engineer of the present day has no right to indulge; he cannot yet afford to wait for the new discoveries that are to throw our works in the shade; like the builders of the pyramids, we must go on plodding in our old-fashioned way, leaving to those of our profession who shall look back upon us from the stand-point of the next century, to say if any of us shall be ranked among the "old masters."

* Address by Vice-President Theodore G. Ellis at the opening of the Eighth Annual Convention of the American Society of Civil Engineers at Philadelphia, June 13th, 1876.

ARCHES;

CONSIDERED GRAPHICALLY.

[Copyrighted 1877.]

(*Continued from page 16.*)

We have thought it better to presuppose that our readers had some knowledge of the equilibrium polygon and its properties, rather than to take up space with any more preliminary matter, and have gone over such ground as seemed needful to refresh the memory of the reader. If any one has failed to follow us thus far we would refer him to the numbers of "ENGINEERING NEWS" for Feb. 26 and March 4, 1876, or to "Graphical Analysis of Roof Trusses,"* which contains the articles referred to.

5. If the rib is made of a rigid material, the tendency to take a shape, other than the one to which it was first formed, will cause a bending action or moment at different points. Thus, between A and C, the rib will flatten somewhat, moving towards the straight line A C, and from C to B it will become slightly more convex. At C, where the rib coincides with the curve of equilibrium, there will be no tendency to bend. The bending moments on either side of a point where the curve of equilibrium crosses the rib will therefore be of contrary kinds or signs. It is necessary to know the value of the bending moments at all points, in order to so design the cross-section of the rib that it shall be able to resist them. The point C is not necessarily the crown of the arch; it happens to come near it in our figure.

If the arched rib is free to turn at its supporting points, there will be no bending moments there; if it is jointed or hinged at any place, as, for example, the middle, there will be no bending there; the curve of equilibrium must therefore pass through all such points. The rib may be so fastened at A and B that it cannot turn in a vertical plane, and there will then be bending moments at those points, as in the analagous case of a beam fixed at both ends, except for such a distribution of the load as makes the curve of equilibrium there coincide with the arch.

6. If the rib is hinged at three points, that is at the ends and middle, the curve of equilibrium is immediately fixed in position by the necessity of passing through these three points, and the problem of finding the stresses in the rib becomes very simple; but we prefer to suppose, at first, that the arch of Fig. 2 is jointed and free to turn at its ends only.

The stress diagram, 012, and the imaginary curve of equilibrium having been constructed, and the horizontal line H from O having been drawn, it will be seen that this line will divide the load line into two forces, the vertical components of the abutment reactions; for 2-0, the pull on A, is resisted by 0-5 and 5-2, the horizontal and vertical components at A, and, similarly, 0-1 is balanced by 1-5 and 5-0. The arrows in the figure denote these components, and we will call the vertical ones, analogous to the supporting forces of a beam, P_1 and P_2, as marked. We have here the usual closed polygon of external forces, as explained in the articles before referred to.

7. Let an imaginary vertical section be made at D F; from the theorem of moments, as equilibrium exists in this loaded arch, the moments of all the external forces must balance around any point, for instance the point E, where the plane of section cuts the rib. If the sum of the moments around E equals zero, the moments on one side of the plane must equal those on the other, and, as E is in the section of the rib, these moments can only neutralize one another through the moment of resistance of the section; consequently, the sum of the moments on either side must equal the bending moment at E. Then at E, if P_2 and H are the rectangular components of the reaction at B, and Σ W. L denotes the sum of the products of each weight by its horizontal distance L from E, the bending moment will be

$$M = P_2 . DB - \Sigma W . L - H . DE. \qquad (1.)$$

If the weights had been attached to the cord, or curve of equilibrium, we should have had, for moments on the right of and about F.

$$P_2 . DB - \Sigma W . L - H . DF. \qquad (2.)$$

But a cord, being flexible, can resist no bending moment. As this cord is the curve of equilibrium, there can be no tendency to move or no bending moment at any point, and expression (2.) must reduce to zero, or

$$P_2 . DB - \Sigma W . L = H . DF.$$

Substitute this value in (1.) and it becomes

$$M = H . DF - H . DE = H . EF, \qquad (3.)$$

which signifies that the bending moment at any point of an arched rib, under any vertical load, is equal to the product of the vertical ordinate from that point to the *proper curve of equilibrium* multipled by H from the stress diagram.

8. It will be noticed that, to the left of C, DF – DE will change sign, becoming negative, and therefore that the bending moment will change in direction, as stated before. If the rib becomes straight and horizontal, the point E moves up to D, and the bending moment becomes equal to H. D F, which is its value for a beam supported at both ends.

**Graphical Analysis of Roof Trusses: Greene*; Chicago, 1876, Geo. H. Frost, Publisher.

Such an arrangement of weights might be devised, continuously distributed along the rib, that there would be no tendency to change the shape of the arch at any point. The curve of equilibrium would then coincide with the centre line of the arch, and we should have what is termed an equilibrated rib. And, on the other hand, a rib can be designed for any given distribution of load, so as to be in equilibrium. This fact can be sometimes made use of when the load is definite, that is, not a moving load, and we shall refer to it again in the sequel.

9. It may have been noticed that, in § 7, we used the term *proper curve of equilibrium.* It has been stated that it is easy to draw, between A and B, any number of funicular polygons, which have their angles on the verticals let fall from the weights, by simply moving the point O horizontally in the stress diagram, and thus altering the value of H, the horizontal component of the tension. But the actual rib, under a given system of weights, must have a fixed value of H, and definite bending moments at all points; there is, therefore, but one funicular polygon which will be the *proper* curve of equilibrium.

Some conditions then must be imposed, and a sufficient one is that, supposing the points A and B to be fixed in position relatively to one another, the distance A B, or the span of the rib, shall be unchanged. An arch between two unyielding abutments satisfies this condition. If the curve A C is flattened by the pull on it, or by the bending moments by which it is urged towards the straight line A C, the point C will move a little to the right, while the portion between C and B will become slightly more convex. The movement of the point B, however, with reference to A, must be zero.

10. Consider the arched rib as disconnected from the points of support, but suspended in the air by the forces which were but now the reactions at those points. Equilibrium will still exist. The bending moment H. E F at E, from its effect on the particles at that section, causing an elongation of the fibres on one side and a compression of the fibres on the other side, produces what may be called an exceedingly small angle in the rib, or better a *change of inclination*, at E, moving the free end B, so far as this change alone is concerned, a very small distance in a direction perpendicular to a straight line from E to B. The amount of this displacement will depend upon the distance E B and upon the change of inclination at E, which change has just been shown to depend upon the bending moment H. E F. The amount, B R, of this change is greatly exaggerated in the figure. But the horizontal component, or projection, B S, of this displacement, which alone affects the horizontal distance of B from A, will manifestly, from the proportionality of the sides of the two right-angled triangles B R S and E B D, be to B R as D E is to E B, or B S will be proportional to D E. Therefore the horizontal displacement of B, from the bending at the section E of the rib, will be proportional to the product of the two quantities H. E F and D E.

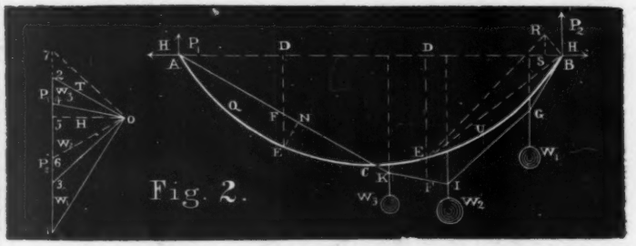


Fig. 2.

But this point may be, perhaps, brought out more plainly, if stated algebraically, thus—

$$BR \text{ varies as } EB . H . EF;$$

$$BS = BR . \frac{DE}{EB}; \text{ therefore,}$$

$$BS \text{ varies as } \frac{EB . H . EF . DE}{EB}, \text{ or as } H . EF . DE.$$

11. Taking all the points in the rib, the total horizontal displacement of B in regard to A would be proportional to $H . \Sigma EF . DE$, if Σ is the sign of summation of all the products E F. D E. As the span A B is to be unchanged, the above quantity must equal zero, and therefore, as H cannot be zero, we have the desired condition reduced to

$$\Sigma EF . DE = 0. \qquad (4.)$$

As E F changes sign when the curve of equilibrium crosses the rib, as at C, we arrive at this result for a rib free to turn, or hinged at its ends, that the *summation of the products E F. D E for every point where the curve of equilibrium lies on one side of the rib must equal the summation of all the similar products for every point where the curve lies on the other side.* Only one curve, manifestly, will satisfy this condition; for if we draw a new curve between A and B, we immediately increase one set of E F's and diminish the other.

(*To be continued.*)

THE INFLUENCE OF THE SEASONS ON ENGINEERING PROJECTS.

The severe cold which we have already experienced this winter, and the large quantity of snow which has accumulated in the Northern States, have given rise to the periodic feeling in many places that better means of communication are needed on some routes of travel. The remarks to this effect which have appeared in the public prints have brought to our notice how much influence the discomforts we experience at certain seasons of the year have to do with the urgent call for public improvements, and how, the immediate necessity for relief having passed away the improvement is postponed until another time.

The inconveniences which the business men of New York have had especially to submit to this winter, in going to and from their homes in the upper end of the island, by reason of the temporary delay and stoppage of street cars, has caused them to redouble their call for the speedy development of some of the schemes for rapid transit. The Gilbert Elevated Railway, already successfully operated for a considerable portion of its contemplated route, was taxed to its full capacity and was unable to supply the number of trains desired. By the way, we are pleased to see that a recent legal decision affords a good prospect that this road will now be permitted to extend its line over South Fifth Avenue. But the snow melts off or is removed in a few days, the public return to the old ways of conveyance, and the strong pressure for relief is relaxed.

When ferry-boats between New York and Brooklyn were wedged in the ice in mid-stream for several hours, crowded with passengers, while thousands were prevented from crossing, the cry for a bridge over the East River arose very strongly. The project was set on foot, and the bridge well under way. Then, through mismanagement, the funds were exhausted before the towers of the suspension bridge were up. After a check in the work of construction, another cold winter and an embargo upon the ferry-boats caused Brooklyn to see the necessity of putting her shoulder to the wheel, and the bridge again advances.

In a similar way, the difficulty which the steam ferries experience this winter in keeping open the passenger and freight communication between Detroit and Windsor, spurs up the tunnel scheme to new life. While the railroad companies which now cross the Detroit river by ferry would undoubtedly prefer a bridge, not only as probably less expensive than a tunnel, but also as likely to prove a hindrance to their great rivals, the navigation interests of the lakes, the city of Detroit is desirous of preserving both lines of business for her own benefit, and therefore favors a tunnel. But it requires a good cold snap and plenty of ice in the river to wake up the people of that city to the idea that they had better take a strong pecuniary interest in the undertaking. Whether a tunnel will be begun this next summer and pushed to completion, remains to be seen, but we feel confident that, if the Detroit river does not get clear of ice for a few weeks, the citizens will take vigorous hold of the project.

The interference with the usual land travel, which the deep snows of winter and what is known in some sections as "mud-time" of spring bring about, starts the agitation for the short lines and branches of railroad which we shall hear so much of for the next few months, and the building of which has been almost the only activity in this line for the past two or three years. In the settled months of summer we do not hear less of such schemes. Then we recall a city at the head of navigation on a river which is closed by ice for some four months in the year; a project for a railroad, extending some eighteen miles down the bank of the river to an open port, was discussed every winter for many years, two or three preliminary surveys were made at different times, one, we believe, more than sixteen years ago, but, with the going out of the ice in the spring, and the arrival of the first steamboat, public interest in the railroad would flag and die out. Finally, two or three years ago, the line was built, and the desired communication established.

Turning to the influence of another season of the year, we are reminded how the dry summers which we sometimes experience, while checking all vegetable growth, encourage the sprouting of a whole crop of water works schemes. When peoples' cisterns give out and their wells fail, they are thoroughly impressed with the necessity for a more reliable source of supply. They agitate, look round for practicable ponds or other points of beginning, appoint committees, and perhaps make some surveys and figure up the cost, but these moves take time, and, before long, the first soaking rain takes all the ardor out of the movement and it lies over until the next dry spell. Just the same fate awaits some irrigating plans every year. When the pressing need of the hour is satisfied, the enthusiasm is dampened most thoroughly.

The way in which so many projects have their ups and downs makes us think of the traveller who sought shelter from a sudden storm in a shanty much out of repair, which was conveniently near. Having found a spot where he would not be wetted by the drippings from a leaky roof, he suggested to the occupant that a few shingles, judiciously applied, might do much good; but the proprietor thought that he could not be expected to go out in the rain to make the repairs, while in pleasant weather they were not needed.

The parallel may not be considered very good, but some private and some municipal affairs are conducted much after this style.

THE ASHTABULA BRIDGE.

We give an abstract of the most important testimony which has been taken, in regard to the Ashtabula bridge, since our last notice, both before the coroner's inquest and before a Legislative committee which has recently commenced an investigation.

Before the inquest, Abraham Gotleib, C. E., of Chicago, chief engineer of the Keystone Bridge company for the western division, formerly chief engineer of the American Bridge company, and a member of the American Society of Civil Engineers, testified that he had made a careful examination of the Ashtabula railway bridge since its fall with the view of discovering the defective members. He was assisted in his labors by Mr. Cretore, of Cleveland. He presented a written report of his findings. After describing the structure very minutely and giving a table estimating the surplus or deficiency of material in the different parts of this bridge, he says the results show that all the members in the bridge except the top chord was excessively heavier than needed, even if the dead weight is assumed as large as 3,000 pounds per foot. The top chords shows in the four panels either side of the centre a lack of material. He finds that the strain on the top chord would be increased by the arrangement of the floor beams upon it. He says in reviewing the details of the construction: "I would like to state beforehand that the Howe truss pattern is not very well adapted for heavy iron bridges for railway traffic, for the simple reason that it contains too many compression members, which if properly constructed require much material, increasing thereby the dead weight of the bridge considerably. The bridge is less able to carry a live load if it has a heavy dead weight to sustain. When the wrecked bridge was constructed the building of iron truss bridges was in its childhood compared with the progress made since that time. The first objectionable point in the bridge, therefore, was the unnecessarily great dead weight. The second was the lack of sufficient sections in the upper chord; also, the manner in which the beams forming said chords were bound together, which brought much more strain on some of them than others." Judging from the position in which the train and bridge fell, he thinks the chances are in favor of the assumption that the vibration braces failed from some cause, the movement probably starting near the centre of the span. The prime cause might of been an engine or car off from the track or any sudden jar. Another possible cause of the rupture, he thinks, may have been a displacement of some of the top lateral rods, destroying in this way the top lateral bracing.

Mr. Joseph Tomlinson was recalled and stated that he had examined the wrecked bridge since the accident and found evidence on the angle-block that some of the braces had slipped out of place before it was last painted, some of them as much as three inches.

The engineer of the Canton Bridge Company testified that he thinks the main braces in the bridge were insufficient; that they contained enough material but were not of proper shape. He thinks that the set braces would have been very much stronger to resist compression if they had been connected throughout their entire length by plates of iron riveted to them. This was the method proposed by Mr. Tomlinson for strengthening them when the bridge was built. Some of the braces had been chipped at their ends to allow room for the rods, which chipping would weaken them somewhat.

Mr. Albert Congdon, who was master mechanic of the Lake Shore road at the time of the construction of the bridge, gives his evidence as to the curious way in which the construction and erection was looked after:

"I know something about the construction of this bridge, as I had charge of the work. In making the bridge I found a lack of material to fill the place for which it was designed. I told Mr. Tomlinson about it and he wanted to know if he had better let Mr. Stone know it. I told him he had better. A short time afterward I was told to take the plans and finish the construction of the bridge as I thought it should be done. I do not know how far the work had progressed at the time I assumed control. The braces were not marked to designate the position they were to occupy. I never calculated the strength of the tension or compression. I did not say much to Mr. Tomlinson or any other man about the bridge, as I did not consider myself a competent bridge man. From the time of Mr. Tomlinson's leaving I had the management of constructing the bridge. As soon as the bridge was completed it was shipped to Ashtabula. There was a recess in the angle block, into which the lateral braces fitted. The lateral braces on top of the cord were fastened to the outside of the angle block by a lug passing about three inches through the angle block. This description applies to the bridge before it was shipped. As soon as the bridge was shipped, Mr. Rogers told me that Mr. Stone had given orders to erect it, but he did not know how. I asked why he did not go and tell Mr. Stone so, and he said he did not like to. I then told him as much as I knew.

The Legislative committee appointed for the purpose took the testimony of Amasa Stone, Jr., former manager of the Lake Shore and Michigan Southern R. R. Among other matter he testified that he was the original designer of the bridge at Ashtabula, that he only superintended the plans, and there was no change of plans after the work was projected by him, but there was an error by the contractors which gave considerable trouble. A brace was put in horizontally, when it should of been vertical. A change in righting the braces was made before the bridge was finished. Mr. Stone says that the superintendency of the construction was in the care of Mr. Tomlinson, until he found him inefficient and discharged him. The bridge was then put in the hands of Mr. Rogers, who he thinks never had put together an iron bridge before.

The committee then examined Mr. Chas. Collins, chief engineer of the Lake Shore Road, who testified as follows:

"I don't know where the original plan of the bridge is except the one at Ashtabula before the coroner's jury. These are not the full working plans. I never saw those, however, they are generally preserved, but these were not. They belonged at my office, but about the time the bridge was constructed I was put at other work and this was put into the hands of another man. I never saw the plans, therefore, as they were not sent to my office. I think that they were up at the shop when the work was done. They would also be wanted when the bridge was set up. The examination of bridges belongs to a man under me. My instructions to the men are to report everything wrong. G. M. Reed is at the head of the examining corps. He has no set time, but works on a general order. Some time in September he reported verbally that the bridge was all right. They have not been required to report in writing on ordinary business. I never ordered any special examination of that bridge; never made any statements to the effect that the bridge was not mine but Stone's. I was once staying at Ashtabula and Mr. Rogers asked me to go and visit the bridge, and I told him the braces were in wrong, but told him that I had nothing to do with it. He requested me to have Mr. Stone come down. I went with Mr. Stone, and he remarked that he was surprised that the braces were in wrong; it was still resting on the trestle-work. When I saw it next it was completed. At the time it was tested the braces were afterward turned and an additional number put in. I made an inspection of it afterward when trains were running over it. I looked at it as an engineer, and thought the yokes about the angle-blocks would hold the braces in position. I did not anticipate any trouble on account of the position of the braces. I considered the fastenings of the braces sufficient. In the change that was made the corners of the braces were chipped off, but this I do not think would affect it materially. I have never made any estimate of the weight of the bridge. I have had no experience in building that kind of a bridge, but it would have been stronger if the braces had been united so as to make them act together

I have never known of another bridge to be built of wrought-iron on this plan. This bridge was an experiment. I think the upper cords were not all the same size. I never saw or examined the strain sheet of the bridge. I never myself made a mathematical examination of the bridge, with a view to ascertaining its safety. There was a guard rail which would prevent the wheel from jumping unless something had been tampered with. I think a locomotive might run across if there was anything wrong. Below the floor were beams or stringers. The bridge was built for a double track, the outside rail being immediately over the chord. The bridge would not be stronger if wider. It would have to be more than twice as strong for a double as a single track. I examined the wreck and found that some of the braces had slipped out of the angle-blocks. Since the accident I have been too busy with the erection of a new bridge to examine as carefully as I desire the material of the wreck. If one or more of the sway rods were to break, the floor would go one way and the train the other. The application of air brakes would be to check the train and, might possibly jump a car from the track.

We have been pained to learn that Mr. Collins, probably distressed beyond measure by this calamity upon a road under his supervision, with which he had been connected many years, shot himself in the head with a pistol, and was found dead in his house at Cleveland on the morning of January 19th.

We add an extract from the Cleveland (Ohio) *Leader* of Jan. 8, which, while not sworn evidence, probably contains some reliable facts:

A reporter of the *Leader* Saturday had an interview with a practical machinist and bridge-builder of this city, who was in the employ of the Lake Shore Company at the time when the Ashtabula bridge was constructed. As a machinist he worked upon the iron parts of the bridge while in the Cleveland shops, and as a draughtsman assisted in preparing some of the working drawings of the structure. His statement is as follows:

The bridge was built in the Lake Shore machine shops, in Cleveland. Work was begun on it in the Fall of 1864. Mr. Amasa Stone had control of the job, though a Scotch engineer named Tomlinson, figured the strains and made the drawings. The design was Mr. Stone's but the bridge was according to the Howe model, with the exception that iron was used in it for greater strength where wood was put in the ordinary Howe truss. When the bridge was built it was the first one in which that change had been made. The substitution of the iron for wood was then an experiment.

The bridge was completed and in position about the 1st of July, 1865. It was put together on supports, and when it was ready for the test, as was supposed, the workmen were ordered to remove the wedges. As they took these from under the bridge it began to settle. The superintendent of the work and others became alarmed, and ordered the men to stop taking out the supports. This they did, but if all the scaffolding had been removed the structure would undoubtedly have fallen of its own accord, it was so heavy. This defect was well known by the men employed upon the work at the time, but it was kept very quiet. No one knew anything about it if he were not present when the removal of the wedges was going on, or was intimate with the leading men employed upon the structure.

As soon as it was learned that a mistake had been committed several engineers made a thorough examination of the job. They found that the truss beams had been placed so that the strain would come on the broadest side, and that these beams should have been so put up that the weight would have fallen upon the narrowest side of the beams, that is, edgewise, or in the direction of their greatest diameter. As soon as this defect was discovered it was accepted as the great mistake in the bridge, and as the cause of the structure settling down when the supports were removed.

The defect in the structure having been discovered, men were set to work to change the truss beams, setting them up edgewise, and putting in four beams where there had been only three, and five where there had been four beams. Thus, while the bridge was made stronger, considerable was added to its weight. The bridge was finally completed in July, 1865, or about one year after the error was discovered. Correcting the defect was slow work since it involved the chipping off by hand of the bridge blocks, and the cutting of heavy beams so that they would clear the bolts.

About the 1st of July, 1866, the bridge was tested, preparatory to being put in use, in the presence of Mr. Amasa Stone, Mr. Charles Collins, now Chief Engineer of the road, and several other prominent gentlemen. But this test was with three engines, and not with six, as has been so often stated since the accident. As these were run on the bridge they weighed about forty tons apiece. At first they were run over the new work at a fair speed; then they were brought on the structure and allowed to stand. As the three engines came on the bridge it was depressed five-eighths of an inch, as measured by Messrs. Stone, Collins, and others. When the locomotives moved off the structure it sprung back three eighths of an inch, leaving it one-fourth of an inch from the original position. These measurements were made in the center of the structure. The test was apparently satisfactory to those who had the work in charge, and immediately the running of trains over the bridge was begun.

Mr. Stone blamed Mr. Tomlinson for the error, and said: "I can't see how so serious a defect in the drawings slipped my eye. I had it in my mind from the beginning that the beams were to be set edgewise instead of flat, as they are now placed." The beams were of wrought iron, and of the form known as the "double R." The placing of such beams with their flat sides toward the superincumbent weight, was, therefore, a serious blunder and had to be radically reformed.

The gentlemen who made the above statement says that he was not present when the supports were removed, but that he was told by several who were present and who were employed upon the work that the trouble was as above stated. He states further that at the final test he was present by invitation of Mr. Stone, and is positive as to the number of engines used in the test, and as to the depression of the structure. He also says the stone work was good with the exception of the west arch, in which there was a crack near the keystone at the time of the test. This, however, he thinks was of little account.

He thinks the great trouble in the bridge was in its weight, which was altogether too great. He also believes the beams should not have been extended beyond the angle blocks, and that in making the change the work was patched up, not thoroughly rebuilt.

We notice frequently, in our exchanges, that roofs have given way in many places throughout the North, from the unusual accumulation of snow. Any structure, in this latitude, should have such an additional load provided for when the design is made.

It is expected that the series of tests applied to the West side pumping engines of Chicago, under the supervision of the committee of experts noted by us in our last, and which have been in progress for the past two weeks, will be completed by the date of our present issue.

We omitted to answer last week our correspondent "F" respecting the location of the quarter corner on the north line of the section shown on page 14 of the News. Having located the northeast and northwest corners of the section by the "jogs" as given in government figures, we would divide the actual distance *pro rata* to the distances as given on the government plat, *disregarding entirely* the existence of the quarter corner to the section north of the town line.

A meeting of persons interested in canal navigation was held, a few weeks since, at Buffalo, to see what measures could be taken to improve the efficiency of these waterways and to revive the traffic. The Belgian system of towing by cable on the bottom of the canal was strongly advocated, and additional steps were suggested for inaugurating such a system; but it was stated that there was already no legal hindrance to the introduction of the plan, and that whenever any one wished to introduce train boats they could do so. One party urged the laying of a T rail upon piles on the tow path, using small locomotives for traction,

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It has been considered very desirable that some efficient means should be found of making one of the wheels on a car axle run loose, as the tractive force on curves will then be sensibly diminished, while the wear on wheels and rails will be very much less. The testimony of Mr. R. W. Fowler, Jr., General Manager of the Philadelphia West End Passenger Railway Co., who had special charge of the narrow-gauge railway at the Centennial Exhibition, is very satisfactory as to the working of the Miltimore wheel and axle. He reports that seven of the thirty-six cars on this road were equipped with this wheel and axle, doing their full share in transporting over four millions of passengers. The gauge of the track was three feet, length three and one-half miles, almost entirely curves, some of 250 ft. radius on grades of 155 ft. to the mile. Six loaded cars with these wheels and axles were drawn with twenty-five pounds less steam than five cars with rigid axles, although each truck of the former cars weighed 3000 pounds more than those under the latter. The tread and flange of a Miltimore wheel, to which the Westinghouse air-brake was applied in making 160 stops daily, show no perceptible wear, while a rigid wheel shows much abrasion. Journal brasses and brake shoes were renewed twice, in some cases, with the rigid wheels, but not even once with the Miltimore wheels, nor were there any hot boxes. There were no renewals: the journals were lubricated but twice in six months. Black oil was used a portion of the time, and then Albany grease. Mr. Fowler is of the opinion that the life of car wheels so mounted must be doubled, with a corresponding saving of wear on the rails, and with but slight difference between the life of rails on curves and on straight tracks. We take these facts in substance from the *National Car Builder*.

From the annual message of the Mayor of Detroit Mich., we extract a few items which will probably be of interest to the profession:

Wood pavement laid in 1876, 106,375 sq. yds.; stone pavements 27,865 sq. yds., at an average of about $1.20 per sq. yd. Experience teaches that wood pavement is a failure. In some streets where it has been laid not over six or seven years, th repairs that have become necessary, amount to almost as much as it would cost to put down new pavement. It is far too expensive to continue its use longer, except perhaps in a few streets that are used for pleasure driving, and around the public library and court h uses; and even then the gutters should be of stone and the center of cedar.

Public sewers, built in 1876, 5 miles and 4,294 feet, and cost $148,425.03, or an average of about $4.84 per lineal foot which includes $4,811.11, the cost of 218 receiving basins; 178 other receiving basins were built at a cost of $9,085.12. Lateral sewers, 7 miles, 1421 ft., averaging 67 cents per lineal foot.

It is a matter of just pride to the citizens that the Board of Water Works have, during the past year, not only paid their running expenses, interest on their bonded debt, laying of pipes and all improvements connected with the old works, but have in addition, a surplus left to apply on the building of the new works. I have no fear, if the commission remain as now constituted, but that the whole debt created for the purchase of land in Hamtramck, will eventually be paid by the Board without resorting to taxation.

The average daily quantity of water pumped was 11,200,000 gallons. No. of families assessed for water rates, 20,466. No. not assessed, 316! The total pipeage of the works is 198 miles, of which two miles were laid the past year for the new works, and eight miles for the present works. Operating expenses $53,119.64. Amount expended in constructing new water works, to Jan. 1, 1877, $675,832.88. They will be put in operation the present year.

The Board of Health, as at present organized, has not perhaps accomplished as much as could be desired. Its powers, without doubt, could be enlarged so as to include in its functions the supervision over the drainage and ventilation of dwelling-houses, the defect in which yearly causes scarlet, typhoid and other fevers. The offensive odors and poisonous gases that emanate from bath-rooms, fixed basins and water-closets, and are now conveyed to our bed-rooms and other apartments, could with proper care be made to escape into the open air. Persons contemplating building should be required to submit plans of the drainage of their premises to the Board, and if in accordance with the regulations, it should be their duty to furnish a certificate to that effect. I am fully satisfied that defective drainage causes more sickness in this city than all other causes combined, and it is a matter to be regretted that the Board of Health have not ere this taken the matter in hand, as I believe it requires our most urgent and immediate attention.

The street opening law should be so guarded as to protect the tax-payers from the manipulations of the speculators, as through their efforts it not unfrequently occurs that miles of streets are opened (which, so far as the public interest is concerned might better remain closed), for the sole purpose of benefitting some particular one's five-acre lot.

REGULAR MEETING OF THE CHICAGO CHAPTER A. I. A.

Held Thursday, January 18th, 1877, 2:30 p. m., at the Secretary's Office, 90 LaSalle Street.

Roll called. Motion made and seconded to suspend the reading of the minutes of the last meeting. Carried. Announcement was made of the death of Mr. Asher Carter formerly an active member of the Chapter, and a motion was made and seconded that a committee be appointed to draft appropriate resolutions. Carried. The President appointed Messrs. F. B. Hamilton and Henry L. Gay. who presented the following resolutions and memoir which was unanimously adopted by the Chapter, and the Secretary ordered to present copies for publication to Engineering News, *American Architect*, and the daily Chicago papers, and a copy of them to be sent to the widow of the deceased:

Resolved, That the Chicago Chapter of the American Institute of Architects does hereby extend its sympathy and deep regret to the relatives and friends of the late Asher Carter, and that by his death there has been removed one who has ever upheld the dignity and honor of the architectural profession, and who, through his quiet and studious devotion to his professional duties, has earned the honor and respect of his colleagues.

Resolved, That the Chicago Chapter, fully knowing

the merits and noble qualities of the deceased, particularly extends its sympathies to his bereaved widow.

Mr Carter came to Chicago in the year 1849, under a commission to superintend the erection of the Second Presbyterian Church, which was located on the corner of Washington street and Wabash avenue, long and familiarly known as the "Spotted Church," which was the first important structure erected in Chicago from studied designs of an architect, the plan having been made by James Renwick, of New York. Mr Carter having become permanently located in Chicago during the superintendency of this church, continued his profession here up to the year 1873, during which time he made three different partnerships, viz., with Mr. Augustus Bauer in the year 1855, which continued till 1861, after with Mr. W. H. Drake, which continued till after 1871, when Mr. P. B. Wight, of New York, joined the firm, with the firm name of Carter, Drake & Wight, which partnership was disolved in the year '73, Mr. Carter retiring entirely from active business.

Mr. Carter has been directly connected and interested in the erection of many of the mercantile buildings of Chicago, together with a number of residences, churches and school buildings.

HENRY L. GAY, *Sec.*

ERECTION OF THE VERRUGAS BRIDGE.*

BY L. LEFFERTS BUCK, C. E.

In an article from the *Railroad Gazette*, September 11th, 1875, headed "Rapid Renewal of Bridges," appears an extract giving inquiries made by Mr. J. Dutton Steele, regarding the plan of erection of the Verrugas Bridge. I was in charge of the work as engineer, from the laying of the first stone to completion. The plans followed in its erection were my original design. Articles have appeared in different papers at various times describing the work; but none that I have ever seen gave a very clear idea of the manner in which it was handled, or the difficulties encountered. Hence, I present the following:

The Verrugas Bridge is situated on the Lima & Oroya R. R., in Peru, S. A., 51.8 miles from Callao. The mean elevation of its grade line above sea level is 5,836 feet, The ravine or *quebrada* which it crosses, furnishes a channel for a very small stream or rill, which coming from the mountains by a rapid descent, and flowing nearly northward, is discharged into the Rimac river, about 800 feet north of the bridge.

The earth in the vicinity of the bridge is a sort of concrete. The west side is the hardest, and is composed of water-washed granite, boulders, cobblestones and pebbles, very closely packed, and the interstices filled with a cementing material, which, undisturbed, is very hard. It requires blasting for its removal. The east side is not quite so hard, having some streaks of bluish clay; but it is pretty thoroughly mixed with rough stones resembling in texture the "blue stone" of which curbs are made in New York. It is very compact and furnishes a good foundation, especially in a dry climate like that at Verrugas. The sides of the ravine are very rugged.

The bridge consists of three iron piers, four iron spans and two stone abutments; in height, pier No. 1 is 179 feet, No. 2, 252 feet, and No. 3, 146 feet; the abutments are 42 feet each, span No. 1 is 125 feet, and spans Nos. 2, 3 and 4 are each 100 feet long. The total length of bridge from centre to centre of end pins, is 575 feet; of which 425 feet is made up by the four spans, and the remaining 150 feet by the three piers. The spans are all "deck" with Fink trusses.

Each pier is composed of three transverse bents, of four columns in each bent, making twelve in each pier. Each column is supplied with a cast iron foot, resting upon a firm pedestal of granite masonry; each pedestal having an area of base and depth proportionate to the nature of the soil in which it is placed. The piers are built up in sections or stories of 25 feet each. At each joint is a casting with a tenon on each end. This casting forms the joint connecting the pieces of the column, and the intersections of the latter with the transverse and longitudinal struts, and the tie rods by which the pier is braced. All columns are what is known as the "Phœnix."

The bridge has a grade of 3 per cent. Provision is, however, made by which all wall plates, bridge seats and roller beds are level.

There would have been considerable risk of error in locating centres of piers and abutments by direct measurement. I therefore first located them by triangulation; setting two monuments opposite each point, at right angles to the bridge line. Then finding a piece of level ground, I measured off a line; putting in stakes corresponding to abutment faces and pier centers. Over this was stretched a small flat steel wire, with one end made fast, and the other passed over a pulley, and having a weight attached to this wire, vertically over each stake, a tag was secured. The whole apparatus was then taken down and the wire stretched across on center line of bridge. Next, by setting up the transit opposite each point, sighting to these tags, and then plunging the telescope, an accurate correction of distances was made.

As the original plans and apparatus for erecting the iron-work have been described in other articles and are pretty well understood by mechanical engineers, it is unnecessary to speak of them here. I believe the only difficulty in using them, would have arisen in getting the material for the piers and the two middle spans down into the bottom of the ravine, and then having to hoist it all to the various positions the pieces were to occupy. I do not think that there could be the least doubt as to their safety. They were, however, abandoned and my own plan (as below described) adopted.

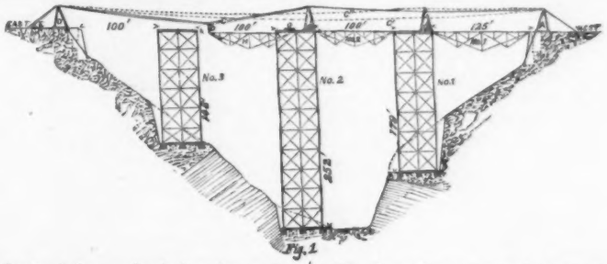


Fig. 1

A sketch (Fig. 1) shows a side elevation of the work in progress; together with the cables, temporary span, etc., and another (Fig. 2), a transverse view of the top section of one of the piers, showing end view of tem porary span. *A* and *D* are two wooden towers, standing on the ground just back of the abutments, and having a height of 30 feet. These towers supported two sets of wire cables—one set vertically over each truss line. The ends of the cables were securely anchored to sticks of timber set in the ground outside of the towers. The position of the cables at the beginning of the work is shown by dotted line *c*. Each cable was supplied with a traveler, *b*, to which was attached a set of block tackle, whose "fall" end was passed over tower *D*, and on to the drum of a winch at *E*. When the tackle was loaded, the strain on the fall was sufficient to haul the traveler out. A tail rope passed from the back end of the traveler over the top of tower *A* and around a cleet, near which a man was stationed for the purpose of paying out or hauling in as was required. *a'* and *a''* show the positions of a third tower used as the work progressed, for the purpose of shortening the span of cables; *c'* and *c''* the respective positions of the cables. H represents the temporary span used to support the iron-work of permanent spans while they were being put together. This temporary span was not used till after all the piers and span No. 1 were completed. It was constructed as follows:—Chords and posts of yellow pine; chains of round iron rods; lateral and diagonal bracing of wood. Its width was such as to allow it to pass between the inner columns of the top section of the piers, by leaving out the diagonal tie rods of the section as shown in (Fig. 2).

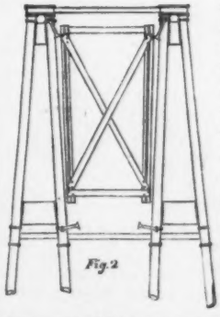


Fig. 2

The materials for the bridge were unloaded from the trains at the west or Lima end of the bridge.

In erecting pier No. 1, the columns, struts, ties, etc., were moved on "push cars" to the abutments, where they were put together—one pair of columns at a time with their joints, castings, transverse strut and tie rods. A piece of plank was lashed across the lower ends of the columns to steady them. The blocks were then lowered from the travelers and made fast to the upper ends of the columns; when the men at the winches raised the load clear of the abutment, the tail ropes were paid out, the columns thus carried out over the pier and set standing in position ready for bracing.

After pier No. 1 was complete, span No. 1 was laid in position, on a scaffolding, built up from the ground. Tower *a'* was then set up, and the material for the other piers run out and put together in front of *a'*. Pier No. 3 was erected next, and pier No. 2 last.

The three 100 foot spans were laid on the temporary span. As soon as one of these was swung up, the temporary span was moved forward to the next opening; the forward end being carried by the travelers, and the back on the iron-work. This operation was repeated for each of the spans.

The time taken to erect the iron-work was three and one half months. Everything worked satisfactorily. Not a man was seriously injured; and the only casuality was the falling of one piece of column by getting loose from the strap. It struck on a stone and was badly broken; but was, however, repaired in such a way as to be as strong as ever.

The excellent manner in which the work went together is evidence of the great care taken by the constructors who furnished it, of their attention to the minutest details of the plans, and of their thorough inspection of the work.—*Baltimore Bridge Co.*

*A Paper read before the American Society of Civil Engineers, Dec. 1st, 1875

MINING TIMBERS.

Some attention is at length being given to the subject of preparing timber for mines in a manner to increase the length of their life. From eight to ten years in mines comparatively dry is enough to weaken timbers to such an extent that they become unsafe and must be replaced. In veins of ordinary size the stopes may be abandoned when filled up, but inclines, shafts, permanent adits, and all working ways need re-timbering at least once in ten years.

In America this question is now becoming one of considerable importance. A number of large mines that were discovered in the early days, are now undergoing repairs, and if the present system of timbering is preserved in the future, the industry will be forced to carry a very heavy additional expense, which will amount to millions annually, and which may be decreased to a large extent by adopting the proper precautions in all future work.

It may be accepted as a rule that woods containing the least water in their composition will give the best results when used raw. The following table gives the comparative proportion of water in the various trees:

Willow	26 per cent.	Horse Chestnut	38 per cent.
Sycamore	27 do	Red Beech	39 do
Mountain Ash	28.3 do	Pine	39 do
Ash	28.7 do	Alder	41 do
Birch	30.8 do	Elm	44 do
Oak—ordinary	34 do	Red Pine	45 do
White Oak	36 do	Larch	48 do
White Pine	37 do	White Poplar	50 do

The following rules should be adopted in selecting trees for heavy timbers:

1. Never cut trees from a marshy or damp soil.

2. Wood cut from a hill side is denser than that growing in a valley or on an open level ground.

3. Select the trees in July or August. At this time of year it is easier to choose the soundest and most healthy.

4. Never cut a tree that has not attained its full growth.

5. In selecting timber, choose that well filled out with leaves and branches at the top, and whose bark is even, firm, and of a uniform color.

6. Cut the tree as near as possible to the ground, for the lowest part is the best wood.

7. Immediately on felling, the tree should be stripped of bark, its limbs cut off, the sap wood removed, and supports placed under it to raise it from the earth.

8. Allow the logs to lie for a year to season. If they are left where they fell, raise them clear of the ground, and take away all bushes, etc., from around them. If the logs are hauled to the vicinity of the mine to season, pile them up on skids, putting a strip of 2-inch timber between each layer, so as to allow a free circulation of air around them. The pile should be covered with a shed.

9. It is advantageous to soak logs for a week or two immediately on felling them. The liquifaction and removal of the sap is thereby hastened. It is also advantageous to allow logs to season for two and even three years if possible.

If the above rules are carefully followed, the life of a mine timber will be prolonged from five to seven years.

Of late years, experiments for the still farther preservation of wood by chemical processes have met with excellent success, and the prepared woods are now used to a considerable extent in railroads, etc. There are numerous patents for this process. Chloride of mercury, chloride of zinc, sulphate of copper, creosote, pyrolyneous acid and various bituminous vapors are used, all with good results.

All these, however, require rather extensive works for their application, and connot be advantageously employed by a single mine. There is an excellent field for enterprising men in our various mining centers in the business of preparing mine timbers, and it is singular that the opening has not been filled before this. Timbers after being well seasoned and prepared chemically by any of the well recognized methods, are worth double the cost of the raw material, while the expense of preparation is about nominal outside of the first cost of the works.

There are a few good plans for adding a few years to the life of even seasoned timber without chemical preparation. The best of these is to paint the wood well, and while the paint is damp, sprinkle with sand.—*The Mining Review.*

[From the City Record.]

DEPARTMENT OF PUBLIC WORKS,
COMMISSIONER'S OFFICE, ROOM 19, CITY HALL,
NEW YORK, January 18, 1877.

To the Honorable, the Board of Aldermen:

GENTLEMEN—I have the honor to acknowledge the receipt of your resolution of the 11th ult., requesting me to report to you as to the advisability and practicability of permitting the Street Cleaning Bureau to open the manholes of the several sewers after each snow storm and emptying therein the accumulation of snow and ice from the streets of this city.

In reply, I beg to state that the unauthorized use of the sewers and receiving-basins for this purpose has been a source of much trouble and expense whenever it occurred. As an instance, I will mention that the manholes of the sewer in Broadway, between Washington place and Fourth street, were opened and filled with snow and ice by men of the street cleaning force in March, 1875, completely stopping up the sewer and causing the flooding of the adjacent cellars. The solid deposit thus formed had to be taken out by hand at great expense.

The number and capacity of the sewer manholes is very small in comparison with the quantity of snow and ice which accumulates in the streets. Many of the old sewers in the lower part of the city were built without manholes, and those that were recently put in to facilitate examinations and repairs are few, and only large enough to give access to the sewers.

Of the small quantity of snow and ice that could be put in the manholes, only a small proportion would be melted, as the temperature in the sewers would soon be reduced below the melting point, and the balance, remaining solid, would stop all drainage.

The most effectual way in which the sewers can be made to contribute to the removal of snow and ice from the streets, is by keeping the gutters, culverts, and mouths of receiving-basins unobstructed. The attention of the Police Department was recently called to this fact, and they promptly responded by approving the suggestions made.

From the foregoing, it is very clear that the emptying of snow and ice into the sewer manholes is altogether unadvisable, and should not be permitted.

Very Respectfully, ALLAN CAMPBELL,
Commissioner of Public Works,

The Block system of signals has been extended upon the Pennsylvania Railroad upon its main line from Philadelphia to Pittsburg, and also upon the New Jersey division.

SURVEY OF THE PUBLIC LANDS—HOW TO TELL TOWNSHIP AND SECTION CORNERS.*

BY JAMES EDMUNDS,
[*General Land Office, Washington.*]

It is proposed in the present article to give a general outline of the system adopted by the Government for the survey of the public lands, the method of running and marking the lines, the approved methods of running lines and establishing corners additional to those required by law to be actually run and marked in the field, and the rule for re-establishing obliterated corners.

The first public surveys were made under the ordinance of May 20, 1785. The townships, six miles square, were laid out in ranges extending northward from the Ohio river, the first township in each range being numbered one. The region embraced by the surveys under this law forms a part of the present State of Ohio, and is usually styled "The Seven Ranges." In these initial surveys only the *interior lines* of the townships were surveyed, but the plats were marked by subdivisions into lots of one mile square, and mile corners were established on the township lines. The lots were numbered from 1 to 36, beginning in the southeast corner of the township, and each succeeding range of sections began with the number next to that with which the preceding one concluded. In fractional townships the lots bore the same number as if the township had been entire. The surveys were made under the direction of the Geographer of the United States.

The act of Congress of May 18, 1796, (U. S. Statutes-at-Large, vol. 1, page 464,) provided for the appointment of a surveyor-general, and directed the survey of the lands northwest of the Ohio, above the mouths of the Kentucky, to which the Indian title had been extinguished. Under this law *one-half* of the townships surveyed were subdivided into sections by running through the same each way parallel lines at the end of every two miles, and by marking a corner on each line at the end of every mile. The sections were numbered by beginning with number one in the northeast section, and proceeding west and east alternately through the townships to the thirty-sixth section in the southeast corner of the township. This method of numbering sections is still in use.

A TOWNSHIP.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

The act of May 10, 1800, (Statues, vol, 2, page 73,) directed the subdivision of townships into half sections of three hundred and twenty acres each, by running parallel lines through the same from east to west and from north to south, at the distance of one mile from each other. Upon the lines running east and west corners were established at every half mile, and upon those running north and south at every mile. It was provided in all cases where the interior lines of the townsphips exceeded or did not extend six miles that the excess of deficiency should be specially noted and added to or deducted from the western and northern ranges of sections, according as the error occurred in running the lines from east to west or from south to north. The act also provided for the subdivision of all previonsly-surveyed townships, the interior lines of which had not been actualy run and marked in the field.

The act of February 11, 1805, (Statues, vol. 2, page 313), directs the subdivision of the public lands into quarter sections, including those townships subdivided under the act of May 18, 1796, above referred to, and provides that all the corners marked in the surveys shall be established as the proper corners of sections or subdivisions of sections which they were intended to designate, and that corners of half and quarter sections *not marked* shall be placed as nearly as possible equidistant from those two corners which stand on the same line. This law declares that the boundary lines actually run and marked in the field shall be the proper boundary lines of the sections or subdivisions for which they were intended; that the lengths of such lines as returned by the surveyors shall be held and considered as the true lengths; and that the boundary lines which shall not have been actually run and marked shall be ascertained by running straight lines from the established corners to the opposite corresponding corners; but in those portions of fractional townships where no opposite corresponding corners have been or can be fixed, the said boundary lines shall be ascertained by running from the established corners due north, south, east, or west lines, as the case may be, to the external boundary of such fractional township.

The act of April 24, 1820, (Statutes, vol. 3, page 566), provided for the subdivision of sections into half quarter sections by north and south lines, fractional sections containing more than one hundred and sixty acres to be subdivided under rules prescribed by the Secretary of the Treasury, but fractional sections containing less than one hundred and sixty acres would not be subdivided.

The act supplementary to the several laws for the sale of the public lands, approved April 5, 1832. (Statutes, vol. 4, page 503), directed the subdivision of the lands into quarter-quarters; that in every case of a division of a half quarter section the dividing line should run east and west, and that fractional sections should be subdivided under rules and regulations prescribed by the Secretary of the Treasury. Under the latter provision the Secretary directed that fractional sections containing less than one hundred and sixty acres, or the residuary portion of a fractional section, after the subdivision into as many quarter quarter-sections as it is susceptible of, may be subdivided into lots, each containing the quantity of a quarter quarter-section as nearly as practicable, by so laying down the line of subdivision that they shall be twenty chains wide, which distances are marked on the plat of subdivision, as are also the areas of the quarter-quarters and residuary fractions.

The two acts last above mentioned provided that the corners and contents of half-quarter and quarter-quarter sections should be ascertained, as nearly as possible, in the manner and on the principles directed and prescribed in the second section of the act of February 11, 1805.

PROJECTION OF SURVEYS.

Under the surveying laws and the existing regulations of the Depaatment the surveys are projected in the following manner: The initial point for the surveys within a given surveying district having been determined upon, a *principal base* line is surveyed on a true parallel of latitude east and west therefrom, and on said line quarter-section, section, and township corners are established at every forty, eighty, and four hundred and eighty chains, respectively. The corners thus established are for section and townships north of the base, but not for those on the south. The *principal meridian* is extended due north and south of the initial point, and similar corners are established thereon, which are common to the townships lying immediately east and west. The law requires that the meridional lines shall be run on the true meridian; therefore, in order to counteract the error that would otherwise result from the convergency of meridians, and also to check errors arising from inaccuracies in measurements on mer dian lines, *standard parallels* or *correction lines* are run and marked at every four townships, or twenty-four miles, north of the base, and at every five townships, or thirty miles south of the same. Guide meridians are next surveyed at intervals of eight ranges, or forty-eight miles, east and west of the principal meridian, starting north of the base, in the first instance, from that line and closing on the first standard north; then starting from the first standard and closing on the second standard north, and so on. South of the base line the guide meridians start from the first standard south and close on the base line; then starting from the second standard and closing on the first standard, and, again, starting from the third standard and closing on the second, and so on. The closing corners on the base lines and standard parallels are established at the intersection of the meridional lines therewith, thus, owing to the convergency of meridians, occasioning a double set of corners on those lines, which are designated as "standard corners" and "closing corners." In rugged mountain regions it has been found

* From Copp's Land Owner.

necessary to depart somewhat from the regular system of extending the standard lines, owing to the impracticablility of surveying them in place. Under these circumstances the principal lines are run and marked in localities admitting of the extension, by means of offsets on township lines, marking them as such in the field.

To be continued.

PERSONAL.

P. H. Dudley, C. E., the inventor of the Dynagraph, is now in Chicago for a few days and letters to him may be addressed to office of ENGINEERING NEWS.

CORRESPONDENCE.

FORT WAYNE, *Jan. 19th, 1877.*

Editor ENGINEERING NEWS:

SIR—In your publication of my letter of the 4th inst., the sine is omitted in the second formula, on the 39th line; D S is used instead of V S on the 40th line; S is also omitted on the 46th line—be kind enough to make some little note of this.

JOHN RYALL,
City Civil Engineer.

WITCH HAZEL.

Editor ENGINEERING NEWS:

SIR:—Although the witch hazel will not turn in my hands without an effort on my part, yet I can follow a "water witch" around, and make the hazel do just what he does, and not be detected by the bystanders; and still I do not feel justified in doubting the word of a "water-witch" whom I have found to be honorable and trustworthy in all other matters. B. F. D.

BOWDOIN COLLEGE, BRUNSWICK, ME. }
Jan. 17th, 1877. }

Editor ENGINEERING NEWS:

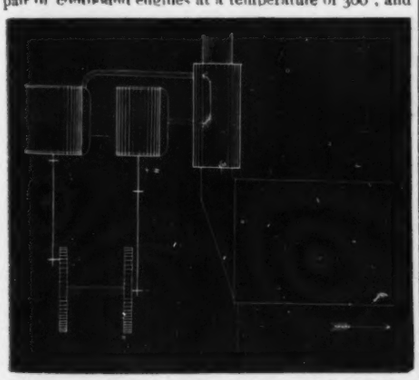
SIR:—I wish to add my opinion to those you have already received in regard to the great value of your paper. I find it an excellent thing for my engineering students to examine, week by week, as it not only contains solid articles of great value, but also many hints and suggestions which furnish them with much food for thought, and awaken much lively interest in the classes, inducing them to study many points which might otherwise escape their notice. Wishing you the success which your efforts deserve.

I remain, very respectfully
GEORGE L. VOSE.

KANSAS CITY, *Jan. 15th, 1877.*

EDITOR ENGINEERING NEWS:

SIR:—Among the many studies for economy of heat in steam engines, there is one that I have not yet seen discussed, although it may not be new or uninvestigated. I can present it more easily in the form of a question. Hot gases from combustion leave a boiler carrying, say 65 or 70 lbs. absolute pressure, at a temperature of say 312°, and escape into the chimney at this temperature; we will suppose that steam is admitted to the smaller of a pair of compound engines at a temperature of 300°, and



is reduced by expansion in the larger to 200°; now here is a loss of 100° of temperature. Why not decrease this loss by returning the exhaust steam to a proper superheater, as shown in the accompanying sketch? Will it not avoid at least a portion of the loss due to conduction and condensation, besides receiving an actual increment of power from this otherwise unutilized heat—at the same time without risk of overheating the machinery? Another question. Why not utilize this heat to surround the cylinder, instead of a live steam jacket, the condensation in which is absolute loss?

I would be glad to learn from competent authority, whether reliable economy is not practible in this manner, and if it is, how much can be expected? G. W. P.

KANSAS CITY, MO., *Jan. 23d, 1877.*

Editor ENGINEERING NEWS:

SIR:—Problem by X, pp. 20, current volume. Have had a similar experience and been perfectly successful.

The question is not friction, though with a rise of 25 feet in 750, there being but about 5 feet of head left to act on, the flow will be necessarily small. The success of a pump under such conditions depends on three essentials: first, that the construction of the pump is such as to have no lurking places for air; a minute amount of air collecting in the pump and not perfectly expelled at each stroke will inevitably cause failure. So will a valve having a small opening compared with the surface bearing on the seat; an easy lifting valve being the second essential. The most important of all is a proper consideration of the *inertia* of the moving water. No ordinary pump will overcome this in a long line of pipe if it works simply by ordinary single stroke, for that requires that the column of water be repeatedly stopped and started. Adequate means must be provided to make the flow of water in the long line continuous. This can be most easily done by a vacuum chamber attached to the suction pipe near the pump, and rising somewhat above it; the attenuated air in this permits water to flow into it during the down stroke of the pump, and thus makes the flow in the long line continuous. The importance of a proper vacuum chamber is not so generally understood by mechanics as that of the air-chamber above the pumps—which in many cases is of much less importance.

G. W. PEARSONS.

NEW LONDON, WIS., *Jan. 4th, 1877.*

EDITOR ENGINEERING NEWS:

SIR:—Allow me to disagree with your reply to "H," Nov. 25, 1876. I think a surveyor should *never* adopt a principle of expediency; and so would accept the last three lines of your advice to "H," first. If "H" desires to know what the courts will decide, he is respectfully and modestly, but very confidently, referred to page 79 of ENGINEERING NEWS for 1875, reading "portions of land," instead of "positions of land."

No man is obliged to abide by the decisions of a county surveyor, or city surveyor, or any other surveyor. If he is not satisfied with the survey of his land, he must take his case into the court. It is the surveyor's duty, and it is within his power, to so understand the law and his business, that the higher courts will always confirm his decision,

If I were surveying under such circumstances as "H" mentions, I should pay no more attention to the lines already run (except government lines), than if there had never been any run.

The sooner people find out the difference between a competent surveyor and a pretender, the better it will be for everybody except the pretenders. B. F. D.

CANTON, ILL., *Jan. 22d, 1877.*

Editor ENGINEERING NEWS.

SIR:—I wish to make some statements relative to two very interesting articles in your issues of Nov. 18th and 25th, 1876, on the "Improvement of the Lower or Des Moines Rapids of the Mississippi River," by E. Hudson Worrall, U. S. Engineer. The original plans and estimates for this work were made by D. C. Jenne, C. E. (now chief engineer of the Illinois River Improvement), under direction of Gen. J. H. Wilson, and I have his authority for this article.

In the second column of the issue of Nov. 18, Mr. Worrall quotes from Gen Wilson's report of Jan. 1st, 1869, giving the dimensions of the proposed canal and the cut in the channel at Montrose. He then speaks of a report made by a "Board of Engineers," recommending certain changes in the details of this plan, and that the recommendations were concurred by the Chief of Engineers and approved by the Secretary of War, and that the work was estimated to cost $3,390,000.

By reference to the report spoken of, it will be found that this amount contemplated the largest sized canal—one 300 feet wide 6 feet deep, with a river bank 20 feet wide on top, and built 4 feet above high water, and a channel in the river at Montrose 200 feet wide and 6 feet deep at low water. Four different estimates were made (found on pages 285 and 286 report for 1867), with the total cost as follows:

1st. For a canal 300 ft. wide and 6 ft. deep, with a channel at Montrose 6 ft. deep. $3,390,000
2d. For a canal 300 ft. wide in embankment, 200 in excavation, and 6 ft. deep, channel at Montrose the same..... 3,110,000
3d. For a canal 300 ft. wide, 5 ft. deep, and a channel at Montrose 5 feet deep..... 2,290,000
4th. For a canal 300 ft. wide in embankment, 200 in excavation, 5 ft. deep, channel at Montrose 5 ft. deep..... 2,710,000

The Board of Engineers referred to in their report gave the total estimated cost on the plan recommended and adopted as $2,530,000 (pages 340, 341 and 342 Chief of Engineer's Report for 1867); this amount is $360,000 less than the amount stated by Mr. Worrall. He states the total cost of the work will be $4 281,000, this is $1,751,000 above the estimate of the Board of Engineers, an increase in cost of 69 1-5 per cent.

Mr. Worrall does not credit any sluices around the locks as being contemplated in the original plans, and says from some unaccountable reason they were overlooked, and that their construction increased the cost. On page 284, report for 1867, special reference is made of the necessity of sluices around the lift locks, and reference is made of their cost being included in the estimate. CHAS. LEVINGS, C. E.

BOOK NOTICE.

FORMULÆ FOR R. R. EARTHWORK, By J. W. Davis. New York: 1876.

This little book is very comprehensive and satisfactory, so far as the theory is concerned at least. The author has carried out his idea of reducing all calculations to one systematic process, and has extended the application of his system apparently to all the cases which arise in actual practice. The *accurate formula* for the contents of a volume is so transposed as to reduce the operations and the sizes of the numbers to be dealt with as much as possible, and one is enabled to calculate the entire contents of a cut or fill, except the small end volumes, at one operation, no matter how many plus stations may be taken. This method possesses the further advantage of using the field notes, exactly as taken. This small volume has been adopted as a text-book at the School of Mines, Columbia College, and is apparently issued under the sanction of that department.

We should be glad to see exact methods, such as the one before us, taking the place of the approximate rules and some of the poor tables which are sometimes used. But we are afraid that the *average section engineer*, who usually has these computations to make, will at first sight, consider this method too complicated and so lay it aside. There is something here left to judgment and discretion in taking field notes, and a method which follows an arbitrary rule, is apt to be better liked.

The author has, perhaps, magnified the importance of his task, as if the computation of earthwork were largely the end of an engineer, in which business an economy of time was of great importance, and takes up considerable space in vindicating the merits of his system over others, although he compares his with the more antiquated, and generally acknowledged imperfect, methods, rather than with the later results of Wellington and others. He does not have so good an opinion of the accuracy of diagrams as we have been led to entertain from our own experience. We cannot speak as well of the mechanical execution of the book as of the matter contained in its covers.

In conclusion we would say that the book is well worth the careful perusal of any engineer who is engaged in such work.

PUBLICATIONS RECEIVED.

Harper's Magazine for February, 1877.

An unusually attractive number of this always interesting periodical.

"*The Fracture of Railway Tires.*" By William Worby Beaumont, Assoc. Inst. C. E., London.

"*The Testing of Portland Cement.*" By Isaac John Mann. From selected papers of the Inst. C. E. London.

Report of the Commissioner of Public Works of the Province of Ontario for the Year 1876. Toronto. 1876.

Transactions of the American Institute of Mining Engineers, Vol. IV., May, 1875 to February, 1876. Easton, Pa. Published by the Institute.

Fifth Report Upon the Improvement of the South Pass of the Mississippi River, Showing the condition of the works on November 18, 1876. By C. B. Comstock, Major of Engineers, Brev't Brig. Gen. U. S. A.

Report of the Jetty System as applied to the Channel of Entrance to Cumberland Sound with Three Charts. By Q. A. Gillmore, Lieut. Col. of Engineers, and Brev't Major Gen. U. S. A. New York: Van Nostrand, 1876.

The New York Street System and Permanent Suburbs. A report to the Board of Public Works of New York city. By Fred Law Olmstead, Landscape Architect, and J. James R. Croes, Civil and Topographical Engineer.

Notes on European Surveys, Compiled under direction of C. B. Comstock, Major of Engineers, Brevet Brig. Gen., U. S. A.; being Appendix H H [in part] of the Annual Report of the Chief of Engineers for 1876. Washington. 1876.

Annual Report upon the Survey of Northern and Northwestern Lakes, In charge of C. B. Comstock, Major of Engineers, Brevet Brig. Gen., U. S. A.; being Appendix H H of the Annual Report of the Chief of Engineers for 1876. Washington. 1876.

Celestial Dynamics, A new Theory with, Discoveries in Astronomy. By Rev. Jas. W. Hanna. Mt. Vernon, Iowa.

In this little pamphlet of 32 pages, the reverend

author has slain Galileo, demolished Kepler, and utterly annihilated poor old Isaac Newton, who it seems did'nt know much about astronomy after all. In the spring of 1876 he confesses that he himself knew very little about astronomy, but by the time of his July vacation he had the "new heavens and the new earth" pretty well organized, when he proceeded to submit his conclusions to Prof. Newcomb of the Washington Observatory, who, however did'nt accept the new theory very readily, when the author proceded at once to that celebrated astronomer, President Grant, who being very busily engaged at the time in some terrestrial observations of his own, referred the author of "Celestial Dynamics" to the "Professors in the colleges." As we are not now prepared to give up the old-fashioned idea of the planets revolving around the sun, and a few other simple theories about the movements of the heavenly bodies, which we learned in years gone by, we must also leave the further consideration of the subject to the author and the "Professors in the colleges." But it is worth the small sum of thirty cents to become acquainted with the new theory, and that is all that is asked.

PRACTICAL TREATISE ON THE CONSTRUCTION OF IRON HIGHWAY BRIDGES for the Use of Town Committees, together with a short Essay upon the Application of the Principles of the Lever to a ready Analysis of the Strains upon the more customary Forms of Beams and Trusses. Alfred P. Boller, A. M. C. E., Member of the American Society of Civil Engineers. New York. 1876. Chicago: Geo. H. Frost. Price, $2.50.

The writer dedicates his book to "Town Committees, Selectmen, County Freeholders, and other public officers to whom is entrusted the responsibility of erecting Iron Bridges;" and in telling them what are the essential elements of a good bridge, he supplies them with a large amount of practical information that has hitherto been inaccessible to them. If he does not succeed in gaining their attention, it will not be for a lack of merit in his work. In undertaking to educate the average committeeman or Freeholder, Mr Boller has addressed himself to a Herculean task; these gentlemen will continue to build as cheaply as the law will permit, and stringent laws alone will prevent the erection of unsafe highway bridges.

The author must be content with having produced a book which is very valuable and useful to the general engineer and to the young bridge engineer about entering upon the practice of his profession. If the former is not an expert in this branch of engineering, he will find here written in a compact, clear, straightforward manner, exactly the hints and information he needs when suddenly called upon to examine bridge plans and specifications, or to act as inspector of bridges; the latter will look in vain in his text books for the practical knowledge that is here conveyed, and that is so necessary to him.

The distinctive physical properties of iron are fully pointed out, the qualities it should possess, and the tests to which it should be submitted, are described so that the inexperienced may judge; then, after a few words of sound advice about timber, the author describes the different kind of bridges in general use, and in regard to the selection of a plan gives this advice, which is good for engineers as well as committeemen: "Ignore any plan of bridge that cannot be accurately analyzed as to the character and amount of strain occurring in all its parts."

There are some very sensible and timely remarks upon connections and upon the merits of the two systems of bridge building—the American and the European—showing how the former so greatly excels the latter, and why it has attained the noble position of being the best system, scientifically and practically, in the world. Struts or posts, eyes and eye-bars, pins and rivets with their sections, sizes and proportions, are fully treated of; while loads, roadways, sidewalks, pavements, in fact, everything pertaining to a highway bridge receives proper attention. Neither do the æsthetics of bridge construction fail of their share of consideration.

The second part of the book is devoted to the consideration of strains in girders and simple trusses, and very simple methods are given for finding them in the ordinary forms in use.

Altogether, the author has more than well fulfilled the task he allotted to himself, and given a large amount of valuable practical information obtainable from no other source.—*Journal of American Society of Civil Engineers.*

NOTES.

Frozen fire-plugs were the indirect cause of a $30,000 fire in Lancaster, Pa.

The fire in the mine near Lykens, Pa., is under control, and the damage is not so great as was thought.

At South Sugarloaf, near Hazleton, Pa., Messrs. A. Pardee & Co., have, after considerable prospecting, struck a new vein of coal ten feet thick.

The Wilkesbarre Coal and Iron Company has just taken a twelve years' lease of a large wharf at New Haven, Conn., and will build a great coal depot there.

At South Bethlehem the Bessemer Steel Works are running with full force on orders which will keep them busy until next spring. Their rail and merchant iron department is but moderately engaged. The brass works, the shovel works and all the lesser manufacturing concerns at Bethlehem are moderately busy.

Directions have been issued by the British Admiralty for the use of slaked lime for the preservation of those portions of the framework of iron vessels which are constantly exposed to the action of salt water. It is to be placed on the iron frames, and in the water contained in such compartments, bilges and wings, as cannot be dried out sufficiently to allow the application of preservative paints.

Steps have been taken to acclimatize the Florida cedar in Bavaria. The superiority of the wood of this tree over all other kinds of cedar is well known, and the demand for the species in Bavaria, where immense quantities of lead pencils are made, has induced manufacturers to venture on the experiment. Seeds have been sown in the royal forest, and about 5,000 young plants are now thriving in one batch.

Captain Eads, in charge of the jetty works at the mouth of the Mississippi, has been awarded the first payment on his contract, amounting to $500,000.

The Maryland and Virginia boundary arbitrators are delayed in making their award, mainly by their differences as to the line to be run from the southern terminus of the Potomac river boundary to the Atlantic ocean.

The question of miners' wages is still in agitation in the Cumberland, Md., coal region. The Consolidation, New Central and Franklin companies have reduced the price of mining from 65 to 50 cents per ton, and other companies are considering the matter. Several meetings of miners have been held, but no definite conclusion has been reached by them.

Public improvements in the city of Washington are entirely suspended, and whether or not there will be any made during 1877 depends on the action of Congress. The field force of the city engineer's office was reduced on the 15th of the month.

The contractors, Messrs. Carpenter and Colbath, having failed to complete the Marshalltown, Iowa, Water-works, according to contract, the city, on Jan. 6th, took possession of the works, and will go on and complete them at the expense of the contractors.

Upon information of Peter Cain, state inspector of mines for Alleghany and Garrett counties, the Maryland and George's Creek coal companies have been indicted under the act of Assembly of 1876, providing for the ventilation of mines and protection of miners, for alleged refusal to furnish at their own expense sufficient "props" for the protection of the miners in their respective works. The law is a very stringent one, and its provisions will be tested in the trial of this case, which, for that reason, will be of great interest.—*Cumberland News.*

A paper upon the currents at mouths of rivers, remarks that where these fall into the sea, an under-current of perfectly salt water, according to the depth, the nature of the bottom, etc., runs up to a quarter or less distance in the opposite direction. The Gotha for instance, half a (Swedish) mile before its entrance into the sea, has water at the depth of two fathoms of almost the same saltness as sea-water at a similar depth, a mile and three-quarters from its mouth. Currents in general are caused not only by the difference in specific gravity, but also by the distribution of rainfall, evaporation, heat, etc., which produce surface changes.—*Harper's Weekly, Jan. 27.*

NOTES AND SUGGESTIONS ON THE CROTON WATER WORKS AND SUPPLY, FOR THE FUTURE.*

BY BENJAMIN S. CHURCH, C. E.

NOTE.—The following comments are not intended to detract from the merits of one of the greatest achievements of modern engineering, or in anywise to underrate the masterly ability displayed and remarkable success achieved, in the plans and construction of the Croton Aqueduct. The wonder is, that so few oversights occurred to challenge criticism, and now, after the lapse of over thirty years, these suggestions are simply offered to carry forward to fuller perfection, the work as it at present stands.

PRELIMINARY.

The Croton Aqueduct is constructed of hydraulic cement masonry and lined inside with brick. The sketch given below shows in section the general form, which is slightly varied in earth and rock tunnels.

The maximum grade of the aqueduct is 1.1088 feet per mile, with the following variations, viz.: at Croton dam, where for 5 miles the fall or grade is about 7 inches per mile; at High Bridge and Manhattan valley, where the water is conducted across in pipes, and a slightly increased fall given to overcome friction, and from Manhattan valley to the reservoir in Central Park, a distance of 2 miles, where the grade is 9 inches to the mile. A considerable portion in crossing streams and ravines, about 5 miles in the aggregate, rests on rubble stone foundations, built up without mortar, and upon these one foot of hydraulic concrete was laid, forming the grade plane sustaining the aqueduct structure. Entirely covering this and its foundations, are earth embankments with outside sloping walls, the object being protection from frost, also to assist in balancing water pressure in the aqueduct.

Now, on all these embankments, one hundred and twenty-five in number, varying from 100 to 14,000 feet in length, and from 10 to 40 feet in height, the masonry enclosing the column of water has not proved of sufficient strength to resist lateral hydraulic pressure of full water flow, and the friction from minute but constant movement always existing in dry foundations. In some places, these foundations have settled and disturbed the even bed of support of the aqueduct, especially as the tendency of this settlement is to spread the wall; consequently, on all these embankments between Croton dam and the city, the aqueduct has split longitudinally through top and bottom, being torn asunder by the above mentioned forces, causing leaks of more or less serious nature. Some of these leaks during a sudden and severe change of weather become so alarming as to make it necessary to shut off the water at Croton dam and empty the aqueduct for repairs, which can only be made inside. Whenever a leak occurs, be it near the upper or lower ends, the entire aqueduct must be emptied. This is necessitated from the fact that waste gate-houses 6 or 8 miles apart, are not provided with cross-gates to enable the water to be stopped at that point and turned out. When such a serious leak occurs—which has been the case on a certain embankment within a few miles of High Bridge—it requires thirty hours to rid the aqueduct of water, in order to repair, and fifteen hours more for the water to reach that point again after being turned on at Croton dam; thus making a loss of forty-five hours, exclusive of the time taken for repairs, when three hours would suffice were there cross-gates as above suggested.

These forty-five hours involve the loss of 220,000,000 gallons to the city in that space of time. The want of strength on these embankments has become more apparent because of the rapidly increasing use of water demanding greater depth of flow in the aqueduct, which entails corresponding increase of lateral pressure, tending to reopen fissures that have been repaired. The outside protection walls have been raised and strengthened, and the embankments more thoroughly drained, which, to a certain degree, has prevented the further settlement of foundations and put the aqueduct in somewhat stronger condition than in former years, to sustain its increased burden. A thorough renewal of the broken parts would, however, require a longer stoppage of water supply than the city storage now allows; therefore, repairs heretofore made, although the best that conditions permitted, have been temporary and imperfect. Had the bottom of the aqueduct, instead of being

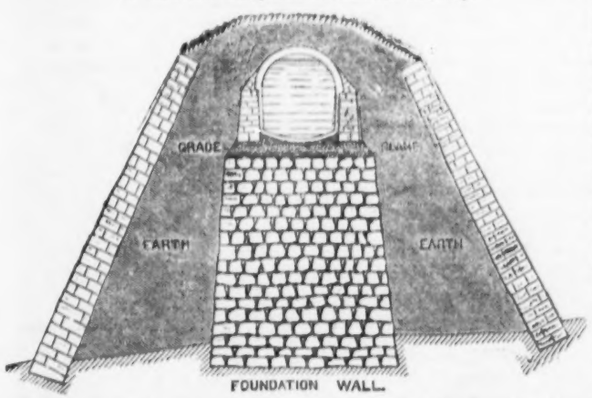
*A paper read before the American Society of Civil Engineers, February, 1876.

formed of 15 inches of concrete and 4 inches of brick, been made 3 feet thick of solid masonry lined with 4 inches of brick and correspondingly increased thickness of side walls, these longitudinal ruptures would hardly have occurred, as therein would have been contained requisite strength on embankments where alone the aqueduct has proved weak.

For some years past the constancy of supply has been maintained by the following expedients, viz.: so soon as a leak appears, sawdust, fine sand or loam mixed with water into a paste, is prepared and dumped into the aqueduct at an opening above the leak and carried down by the current and drawn into the fissures, when it swells and chokes the leak temporarily until some change of temperature or water pressure loosens it, when the process is repeated. By this means, leakage being kept out of these foundations, the movement is much checked, which frequently obviates the necessity of shutting off the water for inside repairs, unquestionably resulting in distress to the city. Increasing vigilance and care have been required on the part of the engineers and their employees to keep up the daily supply.

The city consumption has so nearly reached the carrying powers of the aqueduct, that it can but slowly refill the reservoirs when drawn down. Stoppage occurring for inside repairs, which occupy three days and nights, draws the water down 8 or 10 feet; and this amount of pressure taken from service pipes, is a loss sufficient to deprive upper stories of water, over a considerable area of the city. Under present conditions, should an immediate succession of repairs, such as have occurred, become necessary, the reservoirs would be so reduced that consequences might be disastrous.

A CROTON ACQUEDUCT EMBANKMENT,



In the plans of the reservoir gate-houses, an important change could be made which would relieve the present embarrassment in making repairs, and better regulate city supply immediately following. It should be borne in mind that a full reservoir is now necessary to give full pressure to the city, its high water line being on a level with the top of the aqueduct. The present gate-houses are arranged for the aqueduct to deliver into the reservoir basins, and the main pipes conveying water to the city are supplied from these basins only. Hence every foot lost in the reservoirs is taken from pipe service pressure, only to be regained by refilling the reservoirs. The inconvenience occasioned by this could be obviated by constructing waterways with gates arranged to enable the water to be turned into them directly from the aqueduct and fill to full height the gate house chambers supplying the main pipes. Turning on full water head after repairs, would thus insure its immediate pressure throughout the city, and the surplus beyond city consumption could flow over weirs, and slowly refill the reservoirs at exactly the present ratio. By this means the city could be supplied directly from either the aqueduct or reservoirs as occasion required, and a much larger amount of storage made available. If the city used all the conduit could furnish, this arrangement would, of course, be inoperative, but that need not, and ought not to be, when means are at hand to prevent, as suggested further on.

PIPE DISTRIBUTION.

Comparatively uniform distribution of water can be as readily insured to large as small cities, if they are divided into districts, each district mapped in reference to altitude and provided with a main proportioned to its area. These mains must be so arranged that by opening connecting gates, water can be turned from one to another when occasion requires, either for relaying, repairing pipes, or to increase supply for fire.

When Croton water was first introduced, the mains laid were larger than necessary at the period, and the supply of water so abundant that a very general plan of distribution sufficed. Under present conditions, but small attention has been given to separating the circulation of localities differing in elevation, hence the cause of unequal supply. The growth of Now York has been scattered and irregular, and the power to order pipes laid for newly built localities was formerly in the jurisdiction of the Board of Aldermen. Small street service pipes were connected here and there with the nearest mains, without reference to a well planned system, and it has resulted in a most complicated network of pipe connections delivering without uniform pressure and difficult of control.

Reiterating the statement that the city is consuming nearly the maximum supply of the aqueduct, the question arises how to provide for the present and immediate future? The city average steadily increases, and there is no possibility of increase by the present aqueduct. It is true the falling of the reservoir regulates, in some degree, the use of water by diminishing the pressure, as previously stated; but this diminution is attended by evils that deserve serious consideration. The stoppage of flow in upperstories is, in a sanitary point of view, disastrous. On floors where hand basins and closet traps are apt to be deprived of water direct communication with the sewers is established through drain pipes. These pipes act as chimneys to draw up the poisonous gases, productive of diphtheria, typhoid and otherfevers; or should the same water remain for any length of time in the traps of basins and closets, it becomes charged with these gases and transmits them to rooms to breed pestilence. The difficulty in obtaining full pressure in case of fire, with all the attendant danger and pecuniary loss, need not be enlarged upon.

The true alternative to counteract the evils enumerated is to stop the abuse of the water privilege. An unreasoning impression seems universal among our citizens that water should be free as air and sunlight; but they are oblivious of the fact that Croton water embodies a vast amount of treasure—costing the citizens of New York $6,000 per day, or ov r $2,0 0,000 yearly.

To prevent waste, furnishes the only solution of this problem. Even after the construction of a new aqueduct, a matter of four or five years, which necessitates increased pipe service circulation to deliver the increased supply, the growing habit of reckless waste on each individual in a population constantly enlarging, is like a disease beyond the power of any but temporary remedies, and future years would undoubtedly exhibit a recurrence of present troubles if this habit be not checked.

It is generally supposed that the increased consumption of water has arisen from growing manufacturing interests, and the pumping of water to supply buildings in the lower business portion of the city, which now contains structures double the height of former years. But business houses and manufactories are closed on Sunday, with few exceptions, and use little or no water; yet the reservoirs gain on that day only 6,000,000 gallons, or thereabouts, which is a marked indication that it is in dwelling places and private residences, the principal waste occurs.

Standard authorities have fixed the following data, as a basis for estimating the quantity of water required for abundant supply of cities and towns—minimum 20, and maximum 40 gallons, per head per day. A large estimate of the inhabitants of New York, including transient visitors and people living out of the city, but transacting business within its limits, is 1,100,000 persons; whence the maximum supply would be 44,000,000, and the minimum, 22,000,000 gallons per day. Now the average daily consumption of New York is 114,000,000 gallons, which is more than two and one half times the maximum, and five times the minimum supply, which should amply suffice. The city of London, containing three times the number of inhabitants of New York, daily uses 100,000,000 gallons, thus verifying the above estimate.

With us, there is absolutely no check upon reckless consumption, save in the single instance of steam boilers. These are rated by horse power; yet the establishment using the boiler, may waste at discretion elsewhere through the building, and often much more is used or wasted than is required for the engine, with no possibility (without meters) of measurement or discovery by the authorities.

When the temperature becomes suddenly cold, the water is set running in every house to prevent pipes freezing, turning into the sewers nine or ten millions of gallons and drawing down the reservoirs 3 inches in a night, to recover which, requires three days of mild weather. This amounts to forcing the city government to protect private plumbing, aside from bringing possible danger and disaster back upon households, in robbing upper stories and creating a short supply in case of fire. There are other sources of waste—such as drawing more water than the occasion demands—of themselves insignificant, but multiplied by thousands of similar instances, they assume formidable proportions. Tanks are often so arranged that after being filled at night, when the pressure comes, the water goes on running because no float valve is furnished to stop the flow, and this not only in dwellings, but in factories and wherever water is used in large or small quaantities.

Were each consumer compelled to pay proportionately to consumption, a less expensive method then letting water run would be devised for protecting plumbing. The house main connecting with the street would be laid below the reach of frost, and pipes carried up in the interior, instead of against outside walls, where plumbers, in their own interest, prefer to place them; or they would b encased in charcoal, sawdust, plaster of Paris or any non-conductor; self-closing faucets would be used, causing the water to cease running when the hand is removed. Owners of docks, sugar houses, manufactories, and other places of large consumption, would immediately resort to similar devices to prevent carelessness which would result in personal expense.

The effect of preventing this enormous waste, which (aside from a large percentage for leakage in street pipe service) is estimated to be fully double the amount of water required for use, becomes important because of another law involved than that relating to pressure from a full reservoir. It is the law concerning "the flow of water in pipes under uniform head, viz.: velocity and pressure become interchangeable terms; as velocity increases, pressure diminishes, until it disappears in velocity, and vice versa." Thus velocity being checked, pressure is regained.

In the application of this law, stoppage of waste, (equaling say one-half the supply) diminishes velocity one-half, thus doubling the average pressure throughout the city. The relief of the aqueduct of excessive strain which it now sustains without intermission, dangerously increasing its liability to rupture and leakage, should not be lost sight of in this connection.

Unquestionably the universal adoption of meters by the city is the simplest and easiest method of obviating the difficulties and dangers above enumerated. Meters should be considered in relation to their influence on the water supply as reducing the load carried by the aqueduct and in keeping the reservoirs filled, diminishing velocity of flow in the pipes by checking waste, thereby giving ampler pressure through the city. It is a mistake to view them only as of interest to inventors and speculators, or from the stand-point of increased revenue from water payments which have always accrued from their introduction. Although of great relative importance, the paramount urgency for immediate measures to counteract the present unsafe condition of our water supply should outweigh minor considerations of unreasonable prejudice against their use.

There are various meters existing, to meet every difference of requirement, either for large or small consumption, high or low pressure. Water can be measured by meters with more accuracy than gas, which is compressible. A cubic foot of gas represents more or less according to the pressure brought to bear, while no amount of pressure will sensibly alter the bulk of water. If gas consumers neglect to turn off a high pressure in the cellar, a third more gas may be allowed to flow through burners than is necessary to give the same or even better light. With water this variation is not possible, the meter being far more reliable and honest.

It is urged that payment for water by measurement might lead in some cases to uncleanly, penurious and unhealthy economy. To prevent this, a law providing liberal amount for dwellings according to their size, can rate taxation by the present system. But, beyond this allowance for legitimate use full charge should be made per cubic foot. Having to pay regularly for sufficient amount, whether used or not, no advantage would be gained from mean economy, while waste would involve a pecuniary responsibility. The cost of metering the city would amount to between two or three million dollars, but it would be refunded the city within a few years by increasing the water revenue.

If this method of preventing waste be not resorted to, the only alternative would be to procure an additional supply of water by the construction of a new aquedect. That a new aqueduct, separately located, and independent of the present one, will be ultimately necessary, seems unquestionable. The present aqueduct has been strengthened to the utmost, of late years, but the increased load it is called upon to carry, as before stated, renders it liable to a succession of mishaps such as have formerly occurred, at a time when the situation was far less critical than now, in which event water famine would inevitably result. The city of New York can well afford and should take immediate steps to protect itself from such possible calamity. During the storms of last July, when the Hudson River Railroad and Albany Post Road were rendered impassible, land slides occurred on the aqueduct between Tarrytown and Sing Sing, and had the fury of the storm struck one of three places above, a portion of it might have been seriously damaged. In 1865, during a similar storm, the rush of water carrying debris, choked the culvert under a high embankment, which was cleared at great risk of life, only in time to prevent water damming to the height of 30 feet against the aqueduct, to the immediate danger of the structure.

From the foregoing statements it is evident that action is imperative to provide for emergencies which, if not yet upon us, are none the less threatening. Meters should be applied, or a new aqueduct constructed without delay; the former appears to be the cheapest and most available resource, while the latter must ultimately be resorted to, and fortunately the Croton river offers unlimited supply for all future demands.

A thorough survey of the Mississippi river is to be made from Cairo to New Orleans. Efficient engineers are in charge and careful observations will be made in regard to the wear of the river's bed, the best sites for the construction of levees and whatsoever may come within the scope of the enterprise.

ARCHES;

CONSIDERED GRAPHICALLY.

[Copyright 1877.]

(*Continued from page 22.*)

A curve may first be drawn tentatively, ordinates be measured at intervals, and the above products computed. It will then be readily seen whether the curve should be moved up or down; to move it, change H, and draw again. We can deal thus with a rib of any outline, but, for the regular forms of arches commonly in use, we will show presently how to determine the exact curve of equilibrium without experimental trial.

12. The vertical component R S, of the displacement B R, manifests itself, since B does not move, by a slight movement of the rib at E vertically, corresponding to the deflection of a beam under transverse forces.

13. It has been shown that H. E F equals the bending moment at E. If we draw from E a perpendicnlar E N, to that side of the curve of equilibrium which passes through F, the side being prolonged, if necessary, we shall form a right-angled triangle, similar to one in the stress diagram formed by H, the line parallel to the side of the polygon, and the vertical line. Thus, in the figure, the triangle E F N will be similar to 025, and we may write the proportion

$$0\text{-}2 : 0\text{-}5 = E\,F : E\,N;$$

or, if T denotes the tension 0-2 in the part of the cord which passes through F, multiplying extremes and means, we get

$$H.\,E\,F = T.\,E\,N; \qquad (5.)$$

so that the bending moment at each point is also equal to the product of the tension in the cord by the perpendicular let fall on the cord from the given point. The discussion of the bending moment might have been approached in this way.

14. If a force T acts in the line A K, which, when we consider the curved rib, in an imaginary line, its moment with respect to the rib at E is plainly T. EN, as shown above. Now, from mechanics, if we analyze the effect of a force T at any distance laterally from a point E, we may apply two equal and opposite forces, + T and—T, at this point, which is here the middle of the rib, Fig. 3, or what would be, for flexure only, the neutral axis, without destroying the equilibrium. Hence we have at E the direct force +

T, producing tension, and the couple T. EN, producing flexure. The enlarged sketch will represent the condition of the rib. The small arrows at E′, denote the magnitudes or intensities of the stresses which form the moment of resistance to balance the bending moment, these intensities being taken as uniformly varying, a supposition which is satisfied by experiment within the elastic limit; at E′′ are shown the stresses on the particles of the section from the direct force; and the combination of the force and moment is represented at E′′′, it being understood that these several views represent one and the same section E. The point of no stress, or the position of the neutral axis, is seen to be shifted from the middle of the section at E′ to one side at E′′′, and it will disappear altogether when the arm of the couple or moment becomes sufficiently small, so that the entire section may be under one kind of stress of varying intensity. If we know the form of cross-section of the rib, we can tell from the location of the curve of equilibrium, by simple inspection, where we shall find both tension and compression, and where only one kind of stress. This matter will be treated of later.

15. It is not probable that the direction of T will be parallel to the tangent to the curve of the rib at the particular point, but, when not parallel, the direct force in the rib is in the direction of the tangent, and is greater than T, in just the way that a vertical or horizontal force, when transmitted through an inclined member, as, for instance, the rafter of a roof truss, gives rise to a greater stress in that member. In any case, therefore, the direct force in the arch at any point will be the amount which in horizontal projection will equal H; or, in other words, to find the direct force in the arch, multiply H by the secant of the inclination of the centre line of the rib at that point to the horizon.

16. When an arch is under analysis all the figures which have thus far been given will be inverted. Imagine them to be so. All of the forces will then be *reversed*. The polygon which was under tension will be compressed, and its sides will therefore be struts. It will be in unstable equilibrium, and, not being so familiar to us, is not perhaps so readily apprehended, in its relation to vertical forces, by one not acquainted with this subject. For this reason it was thought best to take an inverted arch first. Hereafter the arches will be drawn above the springing line.

17. The curved rib, between the points A and C, so long as there is tension along the straight line A C, tends to move towards that line, just as the cord, if drawn towards the arch, returns to its former position; but, as soon as the figure is inverted, and C is forced by compression towards A, the arch tends to *move away from the curve* of equilibrium. This fact is true of all points of the rib and must be borne in mind. All the bending moments are therefore reversed. The arch is also under direct compression and tends to force apart the abutments.

It may help to fix the ideas to take a piece of steel wire, such as hoop-skirt wire, bend it into the arc of a circle, and, placing the two ends in two notches upon a board, to notice the change of shape arising from a pressure or load imposed on any portion. The movement of the wire will indicate, in a general way, where the curve of equilibrium lies in reference to the rib.

18. It will be readily seen that the curve of equilibrium for a single, concentrated load on an arch is composed of two straight lines which meet on the vertical drawn through the point where the load is imposed. In the case just treated, these lines will start from the two springing points of the arch. The only quantity needful to fix their position will be the distance of the point of intersection vertically from the rib, and the single condition of § 11, that $\Sigma\, E\, F. D\, E = 0$, is manifestly enough to determine the unknown quantity. It will be easier to find the effect of a single load at successive points on the arch, and to combine these effects for any possible arrangements and intensities of load, than to treat at once several loads. We shall pursue this method.

19. Since an arched rib is often composed of two flanges and a web or connecting bracing, similar to a girder or truss, we desire, after we have found the bending moments at all points, to find that portion of the vertical force or the shear at each section which must be resisted by the web members. If we make a vertical cross-section of a beam at any point and compute the algebraic sum or the resultant of all the external forces on either side of the section, we shall find a certain resultant on one side of the section, and an equal resultant, but with an opposite sign, on the other side of the section. This must be true, for the two equal and opposite forces, applied at the same point, give the equilibrium which is known to exist. But, if the beam were really cut off at this point, these two equal resultants, from forces on opposite sides of the plane of section, would carry the two parts of the beam past one another, as if sheared off mechanically. Hence the propriety of the term *shear*. It is specially the function of the braces or the web of a girder to resist the shearing forces, and hence we ascertain the shear at all points in order to rightly determine the sections of the braces.

In a horizontal beam, carried on two supports, we should have, in Fig. 2, P_2 for the supporting force, and shear on the right of any section between B and W_1; $P_2 - W_1$, or (1-5)—(3-1), for the shear anywhere between W_1 and W_2; $P_2 - W_1 - W_2$, or (3-5)—(4-3), that is—(5-4), between W_2 and W_3; and so on, subtracting each weight from the previous shear or resultant. But in a beam, or a truss with horizontal chords, the other forces, which oppose the bending moment, are horizontal; here they are not. Supposing the rib to have been inverted, the direct thrust, being in the direction of a tangent at the centre line of the rib, has a vertical component which affects the amount of shear to be resisted by the web.

For notice the location of the curve of equilibrium at B. The two components of the stress along G B are H and P_2. If a sufficient amount of P_2 is combined with H to give a resultant coinciding with the tangent to the arch at the point B, that portion of P_2 is all that can come to B in the direct stress exerted by the rib, while the remainder must come as a vertical component of the web stress or as a shear. If G B lies within the tangent, the same reasoning will hold good, but the shear for the web will be of the opposite sign, or a negative quantity, if the first was positive. The end A furnishes such an example. In short, the inclined flanges or chords act as braces, and we have, at any section, these chords as well as the web members, among which to distribute the shearing force. The action corresponds with that of the bow in a bowstring girder.

20. If then we select a point U on the rib, between the weights W_1 and W_2, we may draw the line 0-6 in the stress diagram, parallel to the tangent to the rib at that point, and 0-6 will be the direct force at U. The shear, for a beam, would have been, at that point, (1-5)—(3-1) or 3-5; but 0-6 is composed of 6-5 and 5-0; therefore 6-5 deducted from 3-5 leaves only 3-6 for the amount of shear to be resisted by the web. At the point Q, likewise, we find that the shear, in place of being 2-5, if 0-7 is parallel to the tangent at Q, is (2-5)—(5-7) or — (2-7) to be borne by the web. On passing along the arch from A to and beyond C, if we pass beyond the middle of the span before we pass as much load as is carried at A, the line in the stress diagram which gives the direct stress in the rib will fall below 5, the extremity of P_2, and the amount of shear in the web will be increased by the distance from 5 to the intersection of this line with the load line. It may be seen that the shear which must be carried by the web members is found by taking the distance on the load line included between the extremity of the line of direct force and the end of the weight last passed. A diagram for shear will be constructed when we take up some arches of special forms.

(*To be continued.*)

A BOLD RAILROAD PROJECT.

We find, in the columns of the *American Manufacturer*, some account, from the pen of a correspondent, of a wonderful railroad scheme, which embraces not only a line from San Francisco through Mexico, Central and South America, to Valparaiso and Buenos Ayres, but also one, via Washington Territory, British Columbia and Alaska, to a port on Behring Straits, there to connect by ferry with a proposed road through Kamtschatka, leading indirectly to all parts of Asia and Europe. It is urged that the South American line would open up States which possess all the elements of commercial wealth and offer a fine field for the expansion of American industry. The project was submitted at Philadelphia, this last summer, to the Emperor of Brazil and to his minister to this country, as well as to other ministers from the South American Republics.

The correspondent, above referred to, John A. Lynch of Washington, D. C., states that his project was, to recommend to the several States of Central and South America, the construction of a line of railroad through their respective territories, running north and south, and so arranged that all, united, would form a continuous, direct line from Mexico to Valparaiso, Buenos Ayres, and Rio Janeiro. It is also reported that some of the leading men and capitalists of San Francisco have taken vigorous hold of the scheme.

There is a decided air of plausibility in this project, and it does not seem any more bold and venturesome than did the proposed Pacific railroads before they were undertaken. A cordial harmony of the different governments would, in the course of some years, effect wonders and the whole line, although immensely long, would be pushed forward in sections. However, our neighbor, Mexico, does not offer a very hopeful field for such an undertaking, at the start, and that section would be the first one necessary to be assured. We doubt not that many of the railroad engineers, who have been forced during the past few years to turn their hands to something else, would heartily welcome the inauguration of such an enterprise.

The other project for some reason or other, strikes us as being particularly audacious. Perhaps it is because its advocates propose to brave the rigors and deep snows of winter in such high latitudes and feel able to keep open a line of communication in spite of the climate. That portion of the great route (which they say is distined to connect this continent with Asia and Europe) lying within the domains of Russia has already been surveyed and marked out by Russian Engineers, under the authority of their government—that is, from Moscow, via Orenburg to Pekin, and a port on the Yellow Sea in China; and via Irkoutsk to Nicholaieft, on the Amoor river, and to Ochotsk. Mr. Lynch goes on to say—"For the people of the United States to share in all the advantages to be derived from the completion of such an undertaking, it is necessary for them, through their government, to approach that of Russia, and by treaty lay the foundations for the undertaking simultaneously by both people.

"If the people of the United States will construct a railroad from Washington Territory, connecting there with the Northern Pacific, and through British Columbia and Alaska, to a port on Behring Strait, which is a total length of only about 1,500 miles, there cannot be a doubt but that the Russian government will authorize and encourage the construction of a railroad from Ochotsk, through Kamtschatka to a port on their side of Behring Strait; thus completing a continuous line of railroad from Valparaiso and Buenos Ayres to all Europe and Asia, through the United States."

"In the quiet of his study, our scientist, Professor Henry, whom the learned bodies of all countries delight to honor, has given his consideration to this project, submitted to him by me, and he pronounces it not only feasible, but a work of national importance worthy of the age, and which ought to be carried forward. I have also submitted it to the government of British Columbia, where it has been approved and encouraged, and obtained the promise of all the aid that can be there afforded. I also had it brought before the European geographical convention, held in Paris in May, 1875, where it was warmly approved of by the Russian delegate."

We believe that, where a prospective improvement offers reasonable assurance of being profitable, private capital can be found to embark in the enterprise, and that such undertakings should be pushed through by private means. We are getting too much into the way of applying for a subsidy from the government as a help towards the construction, and then of endeavoring to shirk the obligations of repayment which we took upon ourselves. Railroad projects canal schemes, slack-water navigation, etc., all call for aid from the public purse on the ground of public benefit. If the line of communication is a public benefit, let the public pay for it in tolls of one kind or another, The government will pay for transportation of mails, of troops and of supplies; private freight, or vessels passing through the canal, will be subject to proper charges, and those parties, therefore, who in any way reap the advantage of the improvement, will do their part towards supporting the same. When we are asked to vote government aid towards building a railroad through the rugged and inclement region of Alaska, we shall probably hesitate long before granting it. We presume that grants of alternate sections of public land on each side of the line in that region would hardly induce capitalists to take hold of the enterprise.

THE *Scientific American* makes mention of a "novel method" for removing snow from railroad tracks, invented by a resident of Houghton, Mich. The inventor simply makes use of the same element that piles up these obstructions on railway tracks, to remove the same. Thus a great scoop is placed in front of the locomotive wide enough to clear the whole track at once. Into this the snow is forced by the advancing train, and now, by an artificial blast of air, this mass of snow is instantly raised and forced up through an upright pipe or stack, the top of which is hung on a swivel, which is turned in whatever direction the wind may be blowing. Suppose a train moving at the rate of forty or sixty miles per hour, it is self-evident that the snow would enter the mouth of the scoop at the same rate of speed, but here it would instantly meet with a counter current traveling at the rate of 100 miles per hour, if needed, and this would scatter the snow like chaff before the wind, so effectually, in fact, that not even a pile of snow a foot high would be left within a radius of hundreds of yards from the track.—*Boston Transcript.*

WE agree that this is a "novel method" of removing snow, and it reads as above very neatly. We should be interested, however, in seeing some calculations on the amount of power required to carry up and blow away the snow at the velocity of 100 miles per hour, and at the rate of 40 miles of track per hour. This power we presume is supplied by the locomotive from the surplus which remains after drawing the train at 40 miles.

This inventor runs in the same groove with another Michigan man who sent us for inspection and comment, a project for the cheap conveyance of grain to the seaboard. He proposed to lay down a line of pipe between Chicago and New York, with blowing engines at intervals of a few miles which should create a strong current of air through the tube. Then, as he assumed that any bodies introduced tended towards the centre of the tube so that there would be only the slight friction of air upon the iron, all that remained was to turn in the wheat or corn in a steady stream at Chicago, when it would pass along the axis of the tube, curiously suspended in air, and be delivered at New York with any desired velocity.

At a meeting of the Common Council of New York City January 25th, it was decided, "That the Commissioner of Public Works be requested to report upon the system adopted by the Liverpool Water Board, for the prevention of waste in the use of water and the practicability of applying the same or some similar system to the water pipes in this (N. Y.) city."

A complete description of the system above referred to is given in the paper entitled "On the System of Constant and Intermittent Water Supply, and the Prevention of Waste, with special reference to the restoration of Constant Service in Liverpool." By Geo. Frederick Deacon, M. Inst. C. E., read before the Institution of Civil Engineers, April 27th, 1875, and a pretty complete abstract of which is given in the November and December numbers of volume two of ENGINEERING NEWS, under the heading of "Liverpool Water Supply."

At the same meeting the Special Committee on increased supply of water was instructed to investigate the proceedings of the "contractor for tapping Croton water-mains," against whom certain allegations has been made.

HERE is an idea of what it costs to have the "beautiful snow" in large quantity in New York city:—The work of clearing away the snow and ice commenced on the 14th of January, and was kept up day and night. On the 22d less than eight miles of streets had been cleaned, at a cost of $19,982.73; the quantity removed being 38,802 loads. There are 275 miles of paved streets, of which 75 miles need to be cleaned of snow and ice. At the above rate of expenditure the 125 miles would cost $879,000, and the 75 miles $187,000: as only an unexpended balance of $9,095.20 of the appropriation remained, a requisition for more money was made on the 22d.

IN answer to a correspondent from Detroit, Mich., respecting the use of corners of permanent buildings as monuments in city surveys in Chicago, we publish the following extract, which is all that relates to the subject:

SECTION 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly:* Whenever the owner of lands shall wish to subdivide the same into two or more parts for the purpose of laying out a town, or making any addition to any city, village or town, or re-subdividing any lots or blocks therein, he shall cause the same to be surveyed and a plat thereof to be made by the county surveyor, or some other competent surveyor, which plat shall particularly describe and set forth all the streets, alleys, common or public grounds, and all the in and out lots or fractional lots and blocks within, adjoining or adjacent to the land so divided, giving the names, width, courses and extent of all such streets and alleys, and numbering all lots and blocks by progressive numbers, giving their precise length and width. Reference shall also be made upon the plat to some known and permanent monuments from which future surveys may be made, or, if no such monuments shall exist within convenient distance, the surveyor shall, at the time of making the survey, plant and fix in such manner that the same shall not be moved by frost, at the corners of some public grounds or, if there be none, then at the corners of some lots or blocks most convenient for reference, good and sufficient stones, to be furnished by the person for whom the survey is made, and designate upon the plat the point where the same may be found.

WE reprint below portions of a letter in regard to Railroad Bridge Accidents which we extract from the *Detroit Tribune*, and which is there ascribed to Mr. Geo. T. Clark, fomerly chief engineer of the Flint and Pere Marquette Railroad. We have taken the liberty of abbreviating the communication, by leaving out some parts not absolutely essential, and, while we do not agree with the writer in all points, we find in his letter some valuable suggestions:

Would it not be well before the Ashtabula horror shall have passed out of the minds of the public, for the press of the country to place the responsibility of accidents like this where they properly belong; and is it not time that some attempts be made to get at the causes producing such terrible results? In the first place, what facts has the testimony (thus far brought out) before the coroner's inquest and the Legislative committee given us in regard to the character of this structure? It appears, according to the testimony of Mr. Tomlinson, the civil engineer who was employed to make the plans and specifications of the bridge, it was what is known as the *Howe* truss, made of iron. This class of bridges made of wood has for something over thirty years been largely used in railroad construction, and have been more favorably received by American engineers than any other class of wooden bridges. And here I wish to say that Mr. Stone, the former president of the Lake Shore Railroad Company and President at the time the bridge was built, and who (according to his own testimony) designed the bridge, was the owner of the patent for constructing this class of bridges, and was for many years also a railroad bridge contractor. With him this class of bridges was a specialty. I never knew that he ever made any pretension to scientific acquirements in the art of bridge building. Mr. Tomlinson, it seems, in getting up the plans of the bridge, got into a dispute with Mr. Stone over the size of some of the braces. Mr. Tomlinson insisted that in order to give a certain required strength to the bridge they should be of one size. Mr. Stone, on the other hand, said a smaller, and, consequently, *lighter size, would answer;* and this disagreement resulted in Mr. Tomlinson's discharge from the service of the company. Mr. Stone says in his testimony, that he was inefficient. Mr. Charles Collins, however, who has for more than twenty years been chief manager of the company, sustains Mr. Tomlinson, and says in his testimony that Mr. Tomlinson was right, and that the braces should have been larger, and the whole bridge should have been built in accordance with the Tomlinson plans and calculations. Moreover, he adds in his testimony, that the bridge on the part of Stone was an experiment. After the discharge of Mr. Tomlinson, Mr. Stone employed a man to superintend its construction who never put up an iron bridge, and so

ignorant was he of bridge-building that he got many of its parts together wrong and entirely out of place. This is the testimony of Mr. Collins. With his testimony and that of Mr. Tomlinson, and we may add that of Stone himself, the responsibility of this fearful disaster must rest on Mr. Stone. He cannot get rid of it, for it was through his persistency and conceit, as chief executive officer of the company, a competent engineer was discharged and this faulty structure placed on one of the great lines of travel.

The history of this bridge leads us to say something on the subject of iron bridges.

It is not our purpose to enter into any discussion as to the relative strength of iron compared with wooden bridges, but the general use of iron is of so recent a date that it may be treated as a subject open to examination. * * * * * In many of our great railroad centers there are now large establishments devoted exclusively to the manufaturing of iron bridges, comp tition between which has now become very great. * * * * For instance, a competent engineer is called on to plan an iron bridge for a railroad, and he goes to work on it carefully, guarding all weakness in the use of material and arranging its parts in accordance with plain statical laws. When he presents his plan to the company nine times out of ten he will be told, "We cannot afford that. We must get along with something cheaper, and take the chances," The plan is shown a number of these manufacturing companies and proposals received for its construction, and the bridge let to the lowest bidder. Girders are then made lighter, bolts reduced in size and number, angle irons sheared down, and more or less poor material put into the whole structure. The engineer may protest, but it will be of no use. He will be told: "We cannot afford what you want," and as his bread depends on his employment, he has to submit. Very many of our railroads are dotted their whole length with these light fancy structures for which alone the managers of the roads are in great means responsible. Examine them closely and you will find cast-iron inserted where it ought not to be, and no allowance made for loss of strength, by heat, frost, or misplacement of load. A bridge that cannot bear up its load, if by chance the engine should leave the rail, should not be kept in place a moment. Say what you may, iron is a treacherous metal in a bridge, unless carefully manufactured and each place closely examined, tested and properly put in place.

Width of bridge is an important element of safety. A class of bridges known as flush bridges are so narrow that a person cannot stand on them with any safety while a train is passing. The track being placed on the top chord. there is nothing, in case a wheel leaves the track, to catch it, or prevent the train from turning over. This contingency is unprovided for in a great many of our iron bridges. Our engineering schools now give great attention to this part of the engineering profession, and there is no reason or justification that any thing pertaining to this construction should be left to chance or experiment.

A good bridge may become unsafe from the want of proper care, attention and frequent examination. They are usually left in the care of ignorant track hands whose early education was on the bogs of Tipperary, and their railroad experience gained in the gravel banks on the line of some American railroad. Very many of our railroad companies do not keep competent men to look after their bridges to see that the nuts and keys are tightened and loosened to meet contraction and expansion, and bridges often fail to meet the requirements made of them for want of this attention on the part of the company.

I have already extended this article to a much greater length than I first intended, but the question arises how shall we prevent the occurrence of accidents like this at Ashtabula, for it is the prevention and not the cause of accidents that we seek to reach. The question is one not easy of solution. Iron bridges must of necessity be built, and in the future more frequently than at present. Wood must give way to iron. There is no other alternative. And the responsibility in a great measure, of this dangerous construction must, and does, equally rest with the people as well as with the controlling corporations. The demanding of rapid transit involves the necessity of heavy engines, luxuriant and heavy coaches, the breaking of which is sure to deal out death and destruction. That some legislation is required on this subject no one can deny, and I would suggest, in order to give greater security to travel, that when a road desires to put up a new bridge, they shall first submit plans and specifications of the same, together with a plan and description of the abutments on which it is going to rest; also a full description of the stream or place which it is to span, to the railroad commissioners of the State, who shall take the plans and papers before described and lay them before two or more civil engineers or bridge experts, who shall examine the same in detail in all their parts and report to him, making such suggestions, alterations and improvements as they may deem necessary to secure a safe and reliable structure; and said experts shall make a certificate of same under oath, in which they shall swear that they are not directly or indirectly pecuniarily interested in the bridge, or any bridge manufacturing interest; and the railroad commissioners shall have the power to enforce the construction of the same in accordance with the report of said experts; and the commissioner shall also have the power to appoint an expert to examine all bridges now in use on all the railroad in the State and report the condition of the same to him, and if any are found unsafe the commissioner shall have the power to demand that they be put in immediate repair and in safe condition for the passage of trains; and in the event of their failing to do so within a reasonable time, he shall also have power to prohibit trains from passing over them until such repairs shall have been completed. Something like this, in my opinion, would, in the event of an accident, tend to relieve the company of much of the responsibility that would otherwise rest on them, and add much to the safety of the traveling public.

I would add that in the preparation of this article I am indebted for some of the suggestions in regard to iron bridges to an article on the same subject published in the Boston *Evening Transcript* a few days since.

* * * * * *

G. T. C.

THE ASHTABULA CALAMITY.

SKILL AND CONSCIENCE IN BRIDGE BUILDING.

To the Editors of the Boston Daily Advertiser:—

Before the interest in the subject of bridge construction, which the above-named disaster has called forth in the public mind, has entirely abated, and again none but we sentinels whose business it is to be constantly on guard are left to study the lessons it and other failures, as well as bright examples of success, have taught us; before the recollection in this and other bridge failures has again grown so dim that an engineer's words of warning, his desire to build only the best, and his feelings of responsibility, which few but he can rightly estimate, are all again lightly valued, I wish to say a few words upon this last and sorrowful bridge failure, to the general public. I feel called upon to do so in answer to questions and representations such as these:—

What was the cause? Was it improperly constructed? Was the iron of inferior quality? After eleven years of service, had it 'suddenly' lost its strength, or had a 'gradual' weakness grown upon it unperceived? Might that weakness have been discovered by frequent and proper examination, or was the breakage the sudden effect of intense cold? If so, why had it not happened before in yet more severe weather? Is there *no* method of making iron bridges of assured safety? And who is responsible, so far as responsibility goes, for such an accident,—the engineer who designed the bridge, or the contractor, or the builders, or the railroad corporation? Was the bridge, when made, the *best* of its kind, or the *cheapest* of its kind? Was the contract for building "let to the lowest bidder," or given to the most honest, thorough workmen? These and a hundred similar queries arise in every thoughtful mind, and an anxious community desire information and assurance of safety. The majority of people cannot, of course, understand the detailed construction of bridges, but they do desire confidence in engineers, contractors, manufacturers, who have to do with the making of them, and in the railroad companies, into whose hands they are constantly putting their own lives, and the lives of those dearest to them. —*Harper's Weekly*, Jan. 20.

The sources of my information are: In a general way, a seven years's study, followed by thirteen years practice as a constructing engineer; with particular reference to the Ashtabula bridge failure, a collection of all the principal railroad and weekly engineering journals published in this country since the breaking down of the bridge, editorials and communications in most or all of the New York and Boston papers to date, and the report made by a skillful bridge-builder, after personal inspection, to a society of civil engineers.

"Was it improperly constructed?" This question can be analyzed into several others: Was the design or outline a faulty one? Was the material a proper one, and enough of it in the proper places? Were the several parts properly joined together? Was the work of construction and of erection properly executed?

The general design or outline of the bridge was that of what is called a "Howe truss"; the track over the trusses; inclined, not vertical, end posts. The Howe truss is so-called after William Howe of Warren, Mass., who first built these trusses of wood, with iron vertical tension-rods, and is the wooden truss oftenest met with. It will be recognized by all from its general characteristics: wooden diagonals and top and bottom chords, iron vertical tension-rods. And such a general system of lines or members is a good one.

Something has been said about an arch having been added to the truss, to "strengthen it," when the bridge was first built or some time afterwards. This does not seem to be correct, yet, as it formerly was often done and is still often urged, I take the occasion to say that such a general design is a bad one. A proper truss needs no "strengthening." If it could not be made just as strong as wanted, by itself, it would not be a proper design. It *is* capable of being made of any desired strength. By so doing, the exact amount of load that each member bears at any moment is mathematically fixed, a determination that is lost as soon as either an arch or a suspension cable is added to the truss; hence there is no valid reason why the truss design alone should not be constructed to do its work, whenever the structure pretends to be a truss or beam bridge.

Was the material a proper one, and was there enough of it in the proper places? The evidence shows the material of all the principal parts to have been wrought iron, a proper one in general, and I think of good quality in this instance; and, although it is in evidence that the designer and engineer of the bridge was not allowed to have his way as to the quantity of material in the end braces, but was overruled, and on account of such disagreement between them was discharged by the President of the board—yet, notwithstanding this (upon which point some may lay undue weight), I gather from all the testimony, that the amount of material in all the members of the bridge was such that the bridge did not give way by reason of the failure of any of them from being overloaded. I answer, therefore, that the material of the main parts of the bridge (the joints I consider later) was *not* of "inferior quality," did not "*suddenly* lose its strength," had not "a *gradual* weakness grow upon it unperceived," there was nothing in this direction to discover by "frequent and proper examination."

Were the several parts properly joined together? We touch here upon a most delicate question for a single engineer to answer categorically; for it is precisely upon this question that a discussion has been going on among engineers and bridge builders in this country for the past two or three years, and the subject is one of individual opinion still. It behooves every one, however, to clearly state his opinion, especially so at the present time, to state it calmly, dispassionately and unbiassed by personal interests.

The Ashtabula iron bridge was constructed with a system of joints which latterly has been claimed with pride as peculiarly "American;" without proper reason, perhaps, for it did not originate here, nor is it the only kind in use in the United States. For example, none of that kind are on the New York Central or Hudson River Railroad, nor on our Boston and Albany road; the Connecticut river bridge near Windsor Locks is not of that kind, nor is the Allegheny river bridge in Pittsburg; several American bridge contractors build none of that kind; many American engineers have never, and do not now, design such bridges. But however all that may be, engineering literature has been full of articles on the respective merits of "American" and of "European" or "riveted," iron bridges. There are, of course, several qualities of the "American" or hinged, or butted (as I shall prefer to call them) styles of joint, and Ashtabula was not one of the best; still it is a general characteristic of them all, that *parts in compression are merely butted one against the other, or cast iron is used in short sleeves or "joint boxes"* to help make the joint, whereas a fundamental rule in "riveted" structures is to joint or attach members in compression by rivets, placed and headed while red hot, just the same as members in tension.

There is another characteristic of the falsely so-called "American" style of bridge, in having for tension members single and separate forgings of iron, ending in round eyes, these eyes strung on a single large pin, whereas, in the 'riveted" structure, these same tension members are composed of many smaller pieces, riveted together, and all of these are attached by riveting, as already stated. And still another characteristic difference may be pointed out in the frequent use of bolts and nuts in the first, where the other again uses only rivets, placed and headed up while at a red heat. The discussion spoken of above has taken a wide range and has included considerations of first cost of economy in erecting the bridge, and many more; but as we are now considering solely the question of safety, I, for one, think clearly that in all three of the characteristics above pointed out, and more especially for railroad purposes, the riveted structure is the safest. A heated partisan of the other opinion has gone so far as to argue that because in case a hinged or butted-joint bridge falls into the river, on account of the stone piers being undermined, it falls all to pieces, and the pieces can all be picked up and put together again, and because a riveted structure under like circumstances holds together so well that it requires, and in an actual case did require, dynamite and a good deal of work to reduce it to old iron, and get it out of the way, that therefore the first described structure was the better one. And it certainly is, under those particular circumstances.

But bridges are not built to tumble into rivers and come out unharmed in their several parts; their object in this world, as I understand it, is a different one. It is to afford safe transit over themselves as long as the stone piers stand erect, and the object of the stone piers is to stand erect for the immediate support of bridges. And now reverse the proposition; instead of having the bridge strike in its fall against the river bottom, let the bridge stand still, and have, not exactly the bottom of the river, but any other ponderous body, a derailed locomotive or car-truck, etc., strike it. In such event—not an uncommon one—is it not clear that the bridge that fell all to pieces easiest before will do so again? I think the subject needs no further illustration. Here are the advocates of the one system of making the joints of bridges by their very advocacy condemning their structures for the purpose of withstanding sudden and unexpected shocks, unexpected alike in direction as well as amount. I have, in my own experience, seen a riveted truss while it was being erected, and before it was connected with any other part of the whole bridge, get blown off the abutments by a gust of wind, and fall eighteen feet to the track below; it was lifted up, a fire

built under the corner where it struck first, so that *that* could be straightened out; it was put in place, and is there to-day, after twelve years of service, and this was a cheap kind of a concern at that. Perhaps this behavior is better yet than falling all to pieces, but, in my opinion, the value of the accident was to give a rude measure of what such trusses would endure when in place, and not as they fall.

Something ought to be said here about the use of cast iron in bridges. Many engineers, who will not use it for principal members, still excuse its use in "joint boxes" of butt joint bridges. Riveted bridges use none in any shape. As practice is better than all theory, I begin with the recital of such iron bridge failures as I remember, and add the cause of their failure as I understand it:

Over the Dee, at Chester, England, 1847. Cause, union of cast and wrought iron; bad design.

On the Erie Railroad, 1850. Cause, insufficient material; union of cast and wrought iron.

Over Joiner street, London, October, 1850. Cause, bad design; union of cast and wrought iron.

Czernowitz bridge, Austria, 1868 or 1869. Cause, bad system of joints; union of cast and wrought iron.

Bridge at Dixon, Illinois, May 4th, 1873. Cause, insufficient amount of material and not a first-class kind of design.

This was a road bridge; all the rest and the following one were railroad bridges:

Ashtabula, Ohio, December 29, 1876. Cause, bad system of joints, involving the use of cast iron, and improper work in building and erecting.

The value of this table depends almost entirely on the fact that during an extensive course of reading, this table contains *all* the cases of iron bridges breaking down under their load, that I have met with. Here is a record of thirty years, and cast iron plays a prominent part in all but one of the six cases; and there is no record, as far as I am aware of, of a wrought iron riveted bridge ever having broken down, though some are standing that were built in 1845 and 1846, and although they, as well as all other kinds, had to pass through stages of incomplete development to their present relative state of perfection.

The theoretical reasons for the breakage of cast iron in bridges are several: When introduced as a principal member, with wrought iron, it is shortened by compression in a different ratio from wrought iron, it is expanded and contracted by heat and cold in a different ratio than is wrought iron, both undesirable attributes, to say the least. When used in short pieces or in long ones, it is liable to break by a sudden blow; this liability is largely increased in cold weather; it is a treacherous material at best, breaking, when it does break, without warning. Experiments *have* been made many times to show that cold has no effect on the strength of wrought or cast iron, but they are not conclusive; they only show, one and all, that in the laboratory, under a quiet pull, the application of a freezing mixture produces no change.

The practical fact still remains, to cite no others, that cast steel stone-hammers, when left out over night, are apt to break with the first blow struck in the morning, while if previously warmed up they do not do so. Nor is it entirely outside the bounds of reason to devise and test a theory to meet such cases. Think, for example of the part that the heat produced by a blow is likely to play in these breakages. The rap of a piece of steel on a flint is no tremendous power, and yet it causes enough heat to ignite the particle of steel chipped off, and thus makes the spark that sets fire to the tinder. Can it not be that the intense heat produced in the one point of contact by a blow may have something to do with it, if it is not the *sole* cause of the sudden shivering of a mass of matter permeated by frozen moisture, or more contracted on the outside than it is in the body of it? Then, again, we have the fact that cast iron in cooling often locks up within itself very great internal strains; a homely example of this tendency of all castings are the "Prince Rupert's drops" of glass, that fly to pieces of their own accord as soon as a small piece is broken off them. What a slight breakage does to the one, another trivial cause may produce in the other. I answer, therefore, that the "sudden effect of intense cold" *may* have had something to do with the breakage of that kind of a bridge, and while I will not with one sweep and in one common lot condemn all of the so-called "American" style of bridges, including, as they do, many qualities of bridges, some the work of some of our ablest engineers, men whom all of us respect and honor, I yet must say that simple butt-joints and cast-iron "joint-boxes" should go where are going cast-iron principal members, *out of use;* a large field lies still open to the builders of these bridges in improving and perfecting them, and to the question, "Is there *no* method of making iron bridges of assured safety?" I answer that a wrought iron riveted bridge is, under a test of thirty years experience, beginning at their infancy and extending to the present time, when designed by a competent person, and their construction superintended by such an one, "an iron bridge of assured safety."

Was the work of construction and of erection properly executed? The testimony in the present instance would be a most curious picture of the way not to build a good bridge, were not one or more of its salient features so very common, sad to say. The bridge was designed by an engineer, who is vouched for to me by a competent judge as "honest and conscientous, a firm believer in good material and plenty of it." The President of the road disagreed with this engineer on the manner of constructing certain principal members of the bridge, and, as he says, "Mr. ——— was discharged for inefficiency."

To comment on this is, perhaps, unnecessary; but the kind of "inefficiency" here alluded to is evidently of the kind sometimes given as "sufficient grounds for a divorce," under the name of "incompatibility," a conscientious engineer being *unable*, without the possession of much tact, to remain in the service of some railroad Presidents or Superintendents. Upon this says the President, "Mr. R. was put in his place; Mr. R. had no experience either before or since in the erection of iron bridges, so far as I know." And before the *erection* of the bridge,—'The iron-work was done by as thorough a master-machinist as I know of.' And what says this master-machinist for himself; "I never calculated the strength of tension or compression members; did not say much to any man about the bridge, as I did not consider myself a competent bridge man." Under all these circumstances it almost follows, as a matter of course, that, as testified to, mistakes were made in constructing the bridge—in erecting it parts were at first put in the wrong places; the camber (rise above a perfectly horizontal line) was at first the wrong way, a rise *down* instead of up; this had to be patched up—and, finally, that we shall probably never know what, if any, hidden mistakes or defects the structure may have contained. In any event it does not seem to have had the immediate, daily supervision, care, nursing and improving which every constructing engineer knows to be of the greatest value, that a structure gets when executed by competent brains and hands. Under the circumstances it seems clear that this bridge was therefore *not* "the *best* of its kind," although still far from being "the *cheapest* of its kind," and that the mode of construction and erection left much to be desired.

I come to the moral of the lesson as I understand it. If the responsibility for failures of this sort is to appear clearly and without doubt, some individual class of men must be entrusted with the construction of bridges. There are in every community educated, experienced constructing engineers whose *business* it is to bear such a responsibility; they are *fitted* for it, competent to insure "with their head, if you ask it," as George Stevenson said, the safety of the structures they erect. All *they* ask is that their advice be taken, not overridden by the fancy, perhaps, of a moment. As now too often situated these men are not allowed to build as they know it is proper to build, and yet when anything occurs, the eye of every one is at once turned to them, and them only. A melancholy interest attaches to this part of the subject by the suicide of the chief engineer of the road on which the Ashtabula-bridge failure happened. With the experience of the designer of that bridge before him, an obstinate standing out for his own views would hardly have effected his objects, and tact will not do everything. I desire again to refer to my own practice, and make the statement, that as I look back to the various structures nominally mine, in various places, the rule is that they are the children of ingenious compromises, not such as I would proudly call my own.

If the public will distinguish between surveyors, railroad stakers-out, master-mechanics, professors of mathematics, contractors and constructing engineers (civil engineers I would say, but that the term has well-nigh lost its meaning; if they will appreciate that where the one party to a bargain is (they will pardon the expression) either ignorant of, or what may be equally bad, only a little educated upon a subject, and the other party is knowing and is in the competition with a score of others equally sharp, all trying to beat each other in a race; if they will appreciate that under these circumstances it is the order of nature and of human nature that there is legitimate work for those who have devoted themselves to the full knowledge of the subject matter, without pecuniary interests in who wins the race, and only striving to serve the first party named, then the service of constructing engineers will find its true appreciation.

There is only one correct way of building bridges or large roofs; a constructing engineer must design the bridge or roof; his plans can be changed in details until satisfactory to the parties that pay for it, and all contractors must bid on that one plan. This is fair to all. This is the way all the bridges on the Pennsylvania railroad are built, it is the way they are built on the Boston and Albany road, it is the way bridges are built in Europe universally—it is the only *safe* way. It places the responsibility where it belongs. The distinction between competent civil engineers and gentlemen *not* civil engineers, between engineers and contractors, must be sharply drawn. It will undoubtedly surprise many engineers who have left the profession and taken up bridge contracting, to be told that they *are* no longer of their former profession, and have changed their very nature. But human nature is such and cannot be changed. "No man can serve two masters," and when it comes to advising upon bridge construction, or selecting between several bridge plans, the contractor or "bridge builder" is incompetent by reason of personal interest. We must take a leaf here from the experience and practice of the gentlemen of the law, who for ages have kept the attainment of exact justice and impartiality in view. It is with a feeling of mortification, no doubt, and perhaps with a heavy heart, that a justice of the Supreme Judicial Court sometimes steps from the bench and declines to hear a case in which, say, a railroad company is a party, because he or his wife may own a couple of shares in the road; yet the foundations of justice rest upon such acts; and it is equally proper that the contractor should be equally cautious in giving his opinion free from the taint of any personal interest, and should be encouraged by the public when he is so conscientious as to dislike acting as engineer and contractor both. I believe that all conscientious contractors, men who desire to advance the quality of bridge-work and stamp out the whole tribe of poor workmen and poor work, are anxious to *have* the public have confidence in competent constructing engineers. There is no conflict between the two, for they work in harmony toward the attainment of the same ends.

With that part of the public whose duty it becomes to employ civil engineers, these engineers and the contractors, or the master-mechanic, working together in harmony, and each in his proper sphere, such failures—I decline to call it an accident—as that at Ashtabula will become exceedingly rare, and, should one ever occur, the responsibility ought to, and will, come home like lightning to the proper party.

I remain yours, etc.,
CLEMENS HERSCHEL,
Boston, Jan. 23d, 1877. Civil Engineer

CORRESPONDENCE.

BOSTON, *Jan. 25th, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—In perusing the address "Rise and Progress of American Engineering," reported in your journal of 13th inst., I find several inaccuracies which should not be allowed to pass unnoticed.

First, it is asserted, that a canal connects Washington with Pittsburgh.

Second, that the "National Road," beginning at Washington, passing through Wheeling, terminates at St. Louis.

Third, that a "branch" road (independent) connects Baltimore with Wheeling; and, Fourth, that by means of said roads, time of transit was reduced from eight to three days.

Now the facts are these: The original plan was to connect the Chesapeake Bay with Ohio River, by means of a canal to be known as the "Chesapeake and Ohio," and, no doubt, would have reached its destination, as the object was to bring the coal fields of western Alleghany in *direct* communication with the seaboard, had not the principals in the stupendous undertaking been agreeably disappointed in the full prosecution of the plan, by the discovery of a *better* article of coal in the *eastern* Alleghany, near Cumberland, Md., which latter place *is* the present terminus of the "Chesapeake and Ohio canal," and *not* Pittsburgh.

As to the second statement, almost every school boy in Western Maryland knows that there is but *one* "Turnpike," "National," State or individual, running to Wheeling from Washington and Baltimore, the "branch" which is stated "was constructed to Wheeling" from Baltimore, has no existence farther west than Frederick City, Md. (48 miles from Baltimore), where it unites with the "National Road" and from there is known *only* by the latter name, and only by *that* name as far as Wheeling where it ends as a "*National Turnpike.*"

The fourth, and last declaration to which objection is taken, reveals an error of judgment as well as of fact. We are asked to believe "the time of transit was reduced," by the improvements referred to "from eight to three days." A glance over any accurate map of the United States will show that Wheeling is 250 miles on an *air line*, from Washington, and Baltimore, and about 300 miles by the "National Road." Now, all "old wagoners" agree, that with the advantages referred to, "two-and-a-half miles per hour was pretty fair travelling" when "loaded," and that fifteen hours was an average day's work; by which it would appear that eight days was necessary, even with *good* roads, to the performance of the journey. Indeed, when the enormous size of the wagons used is taken into consideration, laden as they were with from five to eight tons burthen, and drawn over mountains whose summits pierce the clouds, by hard-worked and jaded horses, the wonder is that so great and difficult a task could have been accomplished even in ten or twelve days, and wholly dissipates the assertion that it ever was done "in three days."

Those who stand in such relation to the people that their utterances are taken as matters of fact, should take more pains to inform themselves *thoroughly* about whatever subject they may have to deal with, and not impose on a confiding public.

Let us have things right. MARYLANDER.

TORONTO, *Jan. 26th, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—In the construction of railways, or in renewing the station buildings of old lines, placing the station buildings—especially those for passengers and freight—on that side of the line from which the greater amount of traffic must come, will in so-far reduce the danger to vehicles or pedestrians from passing trains. Experience shows that by far the greatest number of accidents occur at those stations where the buildings stand on that side of the line farthest removed from the hamlets, villages, or towns or whose outskirts such stations are generally located. The reason for this is too obvious to require explanation. Indeed, legislation should secure to the public the proper location of station buildings on all new lines, and the alteration of those on existing lines whose positions are inaccessible save at the imminent peril of property, limb or life.

The Hamilton and Northwestern R. R. bridge over the Burlington canal, near Hamilton was formally opened with some ceremony on the 10th inst. It is an iron swing trapezoidal truss. Depth of truss in the middle, 31 feet, at each end, 24 feet; length 372 feet

Work on the section of the Montreal, Ottawa and Occidental R. R., between Hull and Aylmer, is being pushed rapidly forward this winter. It is to be ready for the passage of trains in July next.

Mr. V. B. Wadsworth, leading partner of the late firm of Wadsworth, Unwin and Browne, Provincial Land Surveyors, of this city, having been appointed Inspector to the London and Canadian Loan and Agency Co. Messrs. Unwin and Browne continue business in the same office on Adelaide street and will, doubtless, well sustain the reputation of the late firm.

The process of *straining* the recent budget speech of the Hon. Adam Crook, in the Ottawa Assembly, yields the following, of interest to railway people and others:—Notwithstanding the liberal grants of aid to various railways within the past year, on the 31st ult, this province rejoiced in the possession of a surplus of something over $4,873,000. Following out the policy inaugurated by the late Mr. Sandfield Macdonald's government—that of granting aid, to a limited extent, in the construction of railways into districts needing them—about $33,000,000 have been advanced for that purpose out of the Provincial funds between the years 1867 and 1876. And this policy has led to the expenditure in the aggregate of $33,000,000 in railway construction

within the same time—not taking into account the Great Western Air Line, the Canada Southern R. R., and portions of the Toronto, Grey and Bruce, and of the Toronto & Nipissing R. R., which did not receive aid from Government. After allowing for the $3,000,000 contributed by Government the great bulk of the remaining $30,000,000 has been raised from local sources, various municipalities interested having contributed over $7,000,000 in bonuses. In 1867 to 1873, inclusive, 1018 miles of railway were built; i 1874, 92 miles; in 1875, 186 miles, and in 1876, 165; total, 1867 to 1876, inclusive, 1461 miles, completed. The wisdom of the Province's railway policy has been clearly demonstrated in the sound, even though depressed, condition of the Province to-day.

From the report of the Victoria Railway Co., just published, it appears that negotiations are nearly completed for the purchase of engines and rolling stock sufficient for the traffic of 1877. The Company have applied to Parliament for a subsidy of $12,000 per mile in aid of the completion of the railway through to the mouth of the Mattawan river, on the upper Ottawa. The Canadian Land and Emigration Co. has agreed to give to the railway company a bonus of $3,000 per mile through that Company's territory.

In your issue of the 13th inst., under the head of "Railroad News," you say: "They are still 'signing contracts' to build Sec. 15 of the Canada Pacific R. R. It is about as far as the section will ever get, or ought to get." Now, all parties interested deeply regret the delays in the letting of the contract above referred to. But these little "hitches," and *rings*, and things, are not peculiar to Canadian soil. It is said they have been heard of even south of the great lakes. And, feeling as we do, implicit confidence in our ability to perform whatever, after mature deliberation, we undertake, we Canadians shall feel obliged if you will "rise and explain" what you mean by the latter sentence above quoted. Is it that the Canadians should have better taste than to construct a formidable rival to the Northern Pacific R. R.? CANADENSIS.

The money now being wasted on this wilderness road to nowhere, might much better be expended in improving existing roads.—[ED.

BOSTON, *January, 1877.*

Editor ENGINEERING NEWS:

SIR:—The following method of keeping level notes I have used with success, especially on long lines of levels, in my practice as engineer of the Fitchburg R. R.

The elevation of each station is found by adding, algebraically, the difference between each reading of the rod, in succession, to the last elevation.

For example, the difference between the readings of the rod at Stas. 0 and 1 is added to the elevation of Sta. 0, giving the elevation of Sta. 1. In the same way the elevation of Sta. 2 is found by adding the difference in the reading of Sta. 1 and 2 to the elevation of Sta. 1.

It possesses the advantage that the elevation of any Sta. can be *checked* at once by adding the sum of any number of differences to their first elevation. This will be readily understood by reference to the following example, taken from my note book:

Sta.	B. S.	F. S.	Diff.	Elv.	Remarks.
0	7.408			284.364	
1		6.57	+0.838	285.202	
2		5.70	+0.87	286.072	
3		5.64	+0.06	286.132	
4		5.50	+0.10	286.232	
5		5.52	−0.02	286.212	
T. P.		5.217	+0.303	286.515	
	6.671				
6		6.13	+0.541	287.056	
7		5.28	+0.85	287.906	
8		5.24	+0.04	287.946	
9		3.93	+1.31	289.256	
10		3.93	+0.00	289.256	
11		4.20	−0.27	289.986	
12		3.28	+0.92	289.906	

To check the elevation of Sta. 12, add (algebraically) the differences from the last station checked, say No. 5, to the elevation of No. 5; thus:

Elevation of No. 5 = 286.212 + (.303 + .541 + .850 + .040 + 1.310 − .270 + .920) = 289.906 = elevation of Sta. 12.

A separate column is used for + and − sights if the ground is very irregular.

For accurate work, on long lines, this possesses a great advantage over the ordinary method.

Never having seen it in print, I venture to hope that it may be new to some of the readers of ENGINEERING NEWS

J. FRANCIS LEBARON.

PLAQUEMINE, LA., *Jan. 17th, 1877.*

Editor ENGINEERING NEWS:

SIR:—There has been an unusual number of "caves," or "land-slides" on the lower Mississippi this winter, and this reminds me of a question, perhaps a scientific one, which I would like to propound: Why is it, that these "land-slides" occur *almost* always at night? To put the word "almost" in figures, I should say 99 in a 100, and feel safe that I am within bounds.

These cavings will subject our poor, politically-stricken State to a terrible devastation from the spring flood. And as we are too exhausted, too flat down with taxes and other robberies, we have nowhere to look to for help but to the national legislature. This institution is, however, too much engrossed with the problem "How to elect a defeated candidate," to give us any attention. Couldn't the question of "Mississippi Levees" be brought before Civil Engineers' Societies in some shape?

E. G.

PORTLAND, ME., *Jan. 24th, 1877.*

Editor ENGINEERING NEWS:

SIR:—Your Paw Paw correspondent informs us that he and his friends of respectability, do not use *Gurley's cheap instruments*, but use Young's (cheap instruments). A left-handed compliment to Young, and an intended fling at Gurley. Such flings are unjust to most any manufacturer. Your own reference to Gurley might be distorted into one, but I had not understood it as such, and do not think you so intended. The word "cheap," as used in your Special for Surveyors, refers, as Paw Paw acknowledges, to the cheap drawing instruments, etc., etc., of unknown manufacturers, that you can buy in most hardware or stationers' stores.

Strictly speaking, the best manufacturers do, according to my experience, and should, as I believe, manufacture cheap instruments. Many conceit themselves to certain purchasers that they do not, but they are easily confronted with the evidence of the fact. How many of us have groaned when we have caught an ambitious assistant, or fresh diplomad C. E. probing or handspiking the very life out of our "made to order instrument." It is for such noviciates that the cheap and passably accurate, but short-lived instruments, should be made. Accuracy, combined with long-living material, determines the rank and value of instruments. The young engineer but rarely enters immediately upon work of great importance; in fact, he becomes quite anxious and even gratified at a chance to air his transit upon a simple house lot or quarter section, and he marks the first few *engineering jobs* with "white stones." During this period it is foolish to hazard the expensive first-class instrument, but the passably accurate, but short lived, and necessarily cheap one, is just commensurate with the period.

My loyalty to Gurley was occasioned by a little incident while I was on the tunnel division of the Central Pacific R. R. Having heard the envious and jealous talk of small manufacturers, I was quite affronted at having an old "Gurley" thrust upon me. Submitting, I overhauled it and probed it gently, and it proved to be the peer of any instrument of that variety that I ever used. It occasioned me to purchase the one that I now have, and pay, not for a *cheap*, but for a good one, and for the price, it equals, if it does not excel, that of any other manufacturer.

JUSTICE.

SURVEY OF THE PUBLIC LANDS—HOW TO TELL TOWNSHIP AND SECTION CORNERS.*

(*Continued from page 26.*)

The parallelograms formed by the base line, principal meridian, standard parallels, and guide meridians, twenty-four by forty-eight miles in extent *north* of the base line and thirty by forty-eight miles *south* of the base, constitute the frame-work of the rectangular system of surveys. These parallelograms are each subdivided into townships six miles square, containing, as near as may be, 23,040 acres, and again each township is subdivided into thirty-six sections one mile square, containing as near as practicable, 640 acres each. The sections of one mile square are the smallest tracts the outboundaries of which the law requires to be actually surveyed. Their minor subdivisions are defined by law, and the surveyors-general, in protracting township plats from the field-notes of sections, designate them in red ink, the lines being imaginary, connecting opposite quarter-section corners, thereby dividing the section into four quarter-sections of 160 acres, and these, in their turn, into quarter-quarter sections of 40 acres each, by imaginary lines starting from points equidistant between the section and quarter-section corners and running to opposite corresponding points. The lines of public surveys over level ground are measured with a four-pole chain sixty-six feet in length, but with a two-pole chain where the surface is broken and hilly. Where uniformity in the variation of the needle is not found the public surveys are required to be made with Burt's improved solar compass, or other instrument of equal utility, operating independently of the magnetic needle; but where the needle can be relied on the ordinary compass may be used in subdividing and meandering.

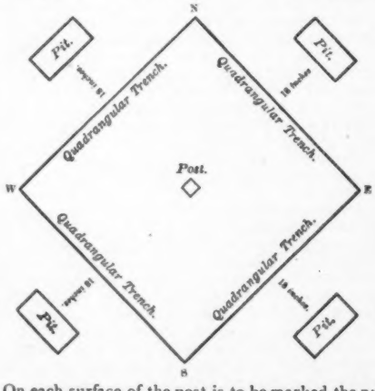
HOW TO TELL CORNERS.

The following extracts from the Manual of Surveying Instructions illustrate the manner of establishing the corners of the public surveys:

Township, sectional, or mile corners, and quarter sectional or half mile corners, will be perpetuated by planting a post at the place of the corner, to be formed of the most durable wood of the forest at hand.

The posts must be set in the earth by digging a hole to admit them *two feet* deep, and must be very securely rammed in with earth, and also with stone, if any be found at hand. The portion of the post which protrudes above the earth must be *squared* off sufficiently smooth to admit of receiving the marks thereon, to be made with appropriate marking irons, indicating what it stands for. Thus the sides of *township corner posts* should square at least *four* inches, (the post itself being *five* inches in diameter), and must protrude *two feet* at least above the ground; the sides of *section corner posts* must square at least *three inches*, (the post itself being *four* inches in diameter, and protrude *two feet* from the ground; and the *quarter section corner posts* and *meander corner posts* must be *three* inches *wide*, presenting *flattened* surfaces, and protruding *two* feet from the ground.

Where a township post is a corner common to *four* townships, it is to be set in the earth *diagonally*, thus:



On each surface of the post is to be marked the number of the particular township and its range, which it *faces*. Thus, if the post be a common boundary to four townships, say *one* and *two*, south of the base line, of range *one*, west of the meridian; also, to townships *one* and *two* south of the base line, of range *two*, west of the meridian, it is to be marked thus:

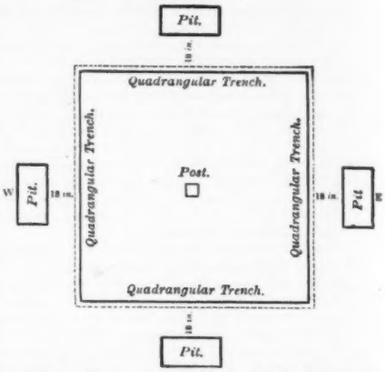
From N. to E.	R. 1 W. T. 1 S. S. 31	From E. to S.	1 W. 2 S. 6
Fram N. to W.	2 W. 1 S. 36	from W. to S.	2 W. 2 S. 1

* From Copp's Land Owner.

These marks are not only to be distinctly but *neatly* cut into the wood, at least the eighth of an inch deep; and to make them yet more conspicuous to the eye of the anxious explorer, the deputy must apply to all of them a *streak* of *red chalk*.

Section or mile-posts, being corners of sections, and where such are common to *four* sections, are to be set *diagonally* in the earth, (in the manner provided for township corner posts); and on each side of the squared surfaces (made smooth, as aforesaid, to receive the marks) is to be marked the appropriate *number* of the particular one of the *four sections*, respectively, which such side *faces;* also, on one side thereof are to be *marked* the numbers of its *township* and *range;* and to make such marks yet more *conspicuous*, in manner aforesaid, a streak of *red chalk* is to be applied.

The following represents a corner mound common to two townships or two sections only:



In every township, subdivided into thirty-six sections, there are twenty-five interior section corners, each of which will be *common* to *four* sections.

A quarter section or half-mile post, is to have no other mark on it than ¼ S., to indicate what it stands for.

NOTCHING CORNER POSTS.

Township corner posts, common to four townships, are to be notched with *six* notches on each of the four angles of the squared part set to the cardinal points.

All mile posts *on township lines* must have as many notches on them, on two opposite *angles* thereof, as they are miles distant from the township corners, respectively. Each of the posts at the corners of sections in the *interior* of a township must indicate, by a number of notches on each of its four corners directed to the cardinal points, the corresponding number of miles that it stands from the *outlines* of the township. The four sides of the post will indicate the number of the section they respectively *face*. Should a tree be found at the place of any corner it will be marked and notched as aforesaid, and answer for the corner in lieu of a post, the kind of tree and its diameter being given in the field-notes.

The position of all corner posts, or corner trees, of whatever description, that may be established, is to be evidenced in the following manner, viz.: From such post or tree the courses must be taken and the distances measured to two or more adjacent trees in opposite directions, as nearly as may be, and these are called 'bearing trees." Such are to be distinguished by a large *smooth blaze*, with a *notch* at its lower end, facing the corner and in the blaze is to be marked the number of the *range*, *township* and *section;* but at quarter section corners nothing but ¼ S. need be marked. The letters B. T. (bearing tree) are also to be marked upon a smaller blaze directly under the large one, and as near the ground as practicable.

At all township corners, and at all section corners, on range or township lines, *four* bearing trees are to be marked in this manner, one in each of the adjoining sections.

At interior section corners, *four* trees, one to stand within each of the four sections to which such corner is common, are to be marked in manner aforesaid, if such be found.

A tree supplying the place of a corner post is to be marked in the manner directed for posts, but if such tree should be a beech, or other *smooth bark* tree, the marks may be made on the *bark*, and the tree notched.

(*To be continued.*)

THE PROPOSED DETROIT TUNNEL.

There have been two or three meetings of citizens of Detroit and others interested in the project; yet little definite progress seems to have been made. Several plans have been submitted and others have been talked of. Gen. Wm. Sooy Smith came prominently forward and stated that he had obtained pledges from gentlemen of means to advance the money necessary to build his tunnel, provided they were guaranteed the interest on the money thus invested. While he could not approximate to the probable cost before a survey was made, he did not believe that it would be greater than for a double track iron bridge and, to decide the matter, he would be willing to make the necessary surveys himself. Mr. P. H. McWilliams proposed to construct a tunnel from a crib sunk in mid-stream, and to have a rising grade archway from the middle, so that the tunnel should drain towards the crib, and the water be pumped out by power at that point. Unfortunately for the respectability of this scheme, the inventor proposes to make a place of resort of this central crib or caisson, on payment of a fee, turning it into an island by means of the refuse excavated material, and opening the shaft and tunnel to visitors by means of an elevator worked by the pumping engine, while he would crown the whole by a lighthouse for the benefit of navigators.

Mr. Eugene Robinson has invented what he calls a portable coffer-dam for tunneling. The dam consists of a float made of boiler iron and timbers, 40 x 80 feet in extent, and five feet deep, forming a chamber which, filled with water, enables the operators to sink the machine. From the centre of this float rise two iron shafts of sufficient height to project well above the surface of the river. On the bottom of the float is a sharp steel shoe which, being pressed into the earth, excludes the water. When anchored at the bottom the water is pumped out of the large chamber, and workmen go down the shafts, at the bottom of which they can work in security. This device will therefore be seen to be analogous to the caissons which have been used at St. Louis and Brooklyn, but is evidently intended to be moved from place to place. We apprehend that the nature of the bottom would have a decided influence upon their successful operation, and no provision seems to be made to weight the coffer or caisson sufficiently to get penetration, and then to admit of removal. However, it is reported that he and his business partner, J. H. Farwell have confidence in their ability to construct a tunnel with its aid, and offer to build one 20 feet in diameter, for $3.500,000, depositing $50,000 in advance. to be forfeited in case of failure, and agreeing to take $500,000 in Tunnel Company stock.

A device of cast or wrought iron sections of cylinder, sunk in line, and joined by flanges and bolts, meets with favor from some. The plan of the tunnel projected a few years ago, whose construction was entered upon and then abandoned, is still considered feasible by many, among whom may be mentioned Mr. Chesbrough, the engineer who proposed it. It was to consist of two parallel tunnels seventy feet apart, one for each track, with a small drainage tunnel below. The tunnels were to be about two miles long, and ninety feet below the water level, the river being about fifty feet deep. This small tunnel was commenced, and after advancing several hundred feet, at an expenditure of some $100,000, and meeting with two or three influxes of sand and water, was stopped. The engineer has stated that he did not desire to increase his estimate of cost, and that he still believed it practicable, We never could see any good reason for abandoning the work, aside from the hard times of 1873-4. unless it was that the railroad officials were pre-disposed in favor of a bridge and thought that permission for one could be obtained from Congress and the Canadian government.

Mr. James F. Joy has, until recently, been the controlling power of the Michigan Central Railroad, and his co-operation was, of course, necessary. What he thought of General Smith's proposal is readily seen in the following letter:

DETROIT, January 22d, 1877.

MY DEAR SIR—I have yours relative to Tunnel Committee and my appointment upon it, for which please accept my thanks.

It will not be possible for me, however, to attend this week, as I am going to New York this evening.

It is, however, of not much importance, because, in my judgment, no such tunnel as Mr. Smith proposes is practicable. Where water is fifty feet deep, and moving from two and a half to three miles an hour, and with twenty feet of soft mud in the bed of the river under it, a part of the way, and hard clay for a part, it is clear that the top of the tunnel must be some more than seventy feet below the bed of the river. This will make it necessary to excavate the bed of the river, all the way across, to the depth of about ninety feet below the surface to the bottom of the tunnel, and in the clay and mud, a depth of from forty to sixty and eighty feet deep, depending upon the depth of the water. This excavation *in the bottom* of such a river across it, *if practicable at all*, will be attended with such expense and difficulty as to be nearly, if not certainly, impracticable, *and so expensive as to be wholly impossible, with any means which can be commanded.*

My presence therefore cannot be very important, though I am obliged to you, and were it possible should be glad to help along. As it is, it is one of those visionary schemes which will serve to divide us, and delay all action till a tunnel is built elsewhere, and we lose the passage here forever.

Yours. J. F. JOY.

ALEX. LEWIS, Esq., Mayor, City.

P. S.—Such a tunnel would involve the removal of a vastly larger amount of earth than the tunnel once begun, and in circumstances of vastly greater difficulty. It would therefore be very much more expensive than that, if its construction be possible.

To this letter Gen. Smith rejoined that he had, upon two occasions, requested Mr. Joy to examine his plans, but the latter had refused to do so, and he thought Mr. Joy erred in pronouncing them visionary, especially as he had no knowledge of what they were.

Mr. Frederick Broughton, general manager of the Great Western Railway, thought that the best method of proceedure was to first consider where the money was coming from. The previous attempt had been given up by the railway companies for lack of funds. If the citizens of Detroit would now join hands with them, he thought the tunnel could be built. It would, in his opinion, cost not less than $3,000,000, and the Great Western Railway Company would do their share in conjunction with the people of Detroit.

W. K. Muir said that railroad companies were loth to bind themselves to enter into any new project without knowing something about the cost. In these days of cheap transportation, with toll to pay over the Detroit and Niagara Rivers, the question was,—Would it mean $3.50 a car, or, as now. 30 cents? It was also remarked by another gentlemen that, unless they could succeed in getting the railroad companies interested, they might as well give up for the city of Detroit had no power to do anything beyond granting a franchise.

So far as we understand Gen. Smith's proposal, he offers to build a tunnel and to receive his pay only when it is completed, the price to be fixed in advance. If the price is reasonable, the proposition looks very fair, and, from what we know of the engineer's ability, we should be pre-disposed to let him try his hand. There is no doubt that a tunnel with a moderate tariff would be of great value to the railroads centering at Detroit, and of most decided advantage to that city. Sooner or later the means of communication between the two shores will be improved. Detroit does not want a bridge, and a tunnel elsewhere will be very damaging in diverting the business which now passes through her borders.

TESTIMONY ON THE ASHTABULA DISASTER.

We occupied so much room in our last issue, by the insertion of the two letters inspired by the Ashtabula disaster, that we will only take space this week sufficient to give a synopsis of the more important portions of additional testimony taken at Ashtabula and Columbus.

Albert Congdon former master mechanic, who had charge of the shop at which the iron of this bridge was put together, testified before the Legislative Committee that the bridge had been intended for a single track. This statement we do not remember to have seen before, and should doubt whether Mr. Congdon was rightly informed; for Mr. Tomlinson, the engineer first in charge would have so stated, if it had been the fact. Mr. Rogers, in testifying before the Committee, adds some statements which we have not given before. He had charge of the putting up of the bridge. In the first place the upper cords of the bridge were too long and they were shortened by planing down the lugs on the brace blocks. The bridge was then put up, but it immediately settled down to almost a straight line. It was then raised up and shims were put in which lengthened the upper chords three and a half inches. The bridge was again let down by knocking out the wedges slowly, but still would not bear its own weight. A second time it was packed up and new wedges put in it, and this time it stood firm and strong.

The engineer of the Canton Bridge Company, having made a further examination of the bridge was recalled before the coroner's inquest. He considers the system of lower lateral bracing employed as insufficient. He thinks the bridge was not as strong to resist lateral motion as it would have been had the track been on the lower chord, instead of the upper, for the reason that there were no laterals from the top angle block to the abutment. Its being a battered-end truss, he thinks the lateral braces and tension rods should have been attached at some point on the lower chord.

James Doran trackmaster, says that a double track was laid across the bridge when it was built but that only one was ordinarily used, until within four or five years; he had never found the rails on the bridge much out of line; he examined the track east of the bridge the morning after the accident, and found no evidence of the train having left the track. There are guard rails the whole length of the bridge.

Job Abbot, vice president of the Canton Bridge Company, testified at the inquest that he found that the tension members had ample section, and in fact were considerably heavier than necessary for safety, and that the compression members were deficient in section. He is of the opinion that the bridge had become gradually weakened by use, the form of construction being such that many of the compression members were strained over their safe working capacity.

Mr. A. H. Howland, a civil engineer from Boston, who examined the wreck, testified before the coroner that the structure was imperfect in many respects. He found evidence that the I beams of the top chord in the south truss was bent toward the south at a point about twenty feet from the west end of the truss. The wooden floor system was such that it could not be depended upon to give lateral support to the bridge. He considers the whole system of lateral bracing a very defective point in the bridge. In his opinion it was a serious defect in the bridge that the compression members depended, to a great extent, upon their function for retaining their proper position. [We take it that this is intended to mean that it was a fault that the braces were kept in place upon the angle blocks simply by the friction which would arise from their thrust.]

Geo H. Carpenter was also examined and testified at Ashtabula that at the time the bridge was built he was employed in the Lake Shore shops at Cleveland, but afterward had charge of the raising of the bridge, with Mr. Rogers, under his directions. When the braces was sent from the shops to the bridge they had no marks on them to show where they belonged. After the bridge was erected, Mr. Stone expressed himself well satisfied with the work, and said it had been well done. Witness did not consider the system of lateral bracing in the bridge good for anything.

Of course much of the testimony of railroad hands and others, which has been taken, is only valuable so far as it relates to matters of fact and not to matters of opinion. Judgments as to the strength of various parts, and the theories which are offered since the accident, have more or less weight according to the source from which they come. We have been surprised, as we look over the public prints, to see what strange suggestions are thrown out by persons who feel called upon to theorize upon this subject. Most of them are not worth refutation nor reproduction for the readers of the NEWS. We were surprised to see that Mr. Stone in his testimony before the Legislative Committee, stated that carrying floor timbers on the upper chord at other points than joints did not affect the strength of the chord materially. He has been called a bridge builder of great experience, and certainly ought to be well informed on that point. We will close with the abstract below. Magnetism, low temperature, crystallizing, etc., do not seem necessary, in order to account for the sad result.

COLUMBUS, O., February 1.—B. F. Bowen, Thos. H. Johnson and John Graham, civil engineers employed by the Legislative Committee to investigate the Ashtabula railroad disaster, have submitted a sworn statement of facts ascertained by them. After referring to their calculations on the relative strength of different parts of the bridge, and their observations at the wreck they submit the following conclusions:

First—That all the tension members had very large factors of safety, and were abundantly able to sustain all the strains that could possibly come upon them in this bridge.

Second—That all the compression members, except the counter braces were deficient in capacity, having very small factors of safety.

Third—Considered with reference to the location of the break, it appears that the weakest point in the braces was at and near the break, and that the weakest point in the top chord was at the center, though the top chord at the point of failure does not show a state of security much greater than that of the braces. The probability is that the braces failed first, and thereby involved the failure of the top chord also. But inasmuch as both members were weak and were involved in the break, it is of little importance which member took precedence in the failure. The factors of safety throughout the compression members were so low that failure must have followed sooner or later.

At this point the engineers proceeded to say how the failure might have been prevented at a moderate cost. The remainder of the sworn statement of the engineers is devoted to a consideration of other defects in the bridge. While these defects were not directly the cause of the failure they were such as might, in themselves, have led to it. They further add that the material, so far as they were able to judge, was of superior quality, and with few exceptions the workmanship was very superior. In conclusion, they say that they find nothing in the case to justify popular apprehension that there may be some inherent defect in iron as a material of bridges. They find no evidence of any weakness in this bridge which could not have been discovered and prevented.

THE President has recently sent a message to Congress, calling their attention to the necessity of continuing the board for testing iron and steel, and recommending a small appropriation for that purpose. The value of experimental knowledge is referred to, and the Ashtabula bridge is cited as an example where a better knowledge of iron might have averted a calamity.

A report upon Rapid Transit for New York city has been made by Messrs. W. J. McAlpine and E. L. Viele, in which they unqualifiedly condemn elevated roads for steam cars, and characterize the one already in operation in that city as a dangerous experiment. Still, the Gilbert Elevated Railway is doing a fine business, and solving the problem of rapid transit, while the other schemes are yet being debated upon.

THE *Scientific American*, for Jan. 20, contains an interesting article on Rope Gearing, meaning the substitution of ropes for belts or toothed gears for the transmission of power, and refers to two papers, one by Mr. James Durie, read before the Institution of Mechanical Engineers, at Manchester, England, and the other by Mr. K. Keller, published in the *Zeitschrift des Vereins der Deutscher Ingenieure*.

ANY apprehensions of danger from the rapid melting of the great quantity of snow on the ground in this vicinity have, happily, passed away. In the streets of Chicago "mud-time" has prevailed of late very decidedly, but our excellent sewerage system has conveyed away the surplus water most effectively, and a few more days of the labor of the street cleaning brigade, will remove a large part of the accumulated filth of the past months, and give to the city a much more presentable appearance.

THE annual meeting of the Poughkeepsie Bridge Company was held on January 3d, when the treasurer made a satisfactory statement in regard to the payment of the first assessment of ten per cent., or $100,000. Mr. Rust, of the American Bridge Company, reported that the preliminary work was being pushed forward rapidly; that one caisson was ready for launching, others were in progress, and that the company expected to build all four of the piers in the channel up to at least twenty feet above highwater before the close of navigation next fall.

THE *Manufacturing and Trade Review* of Cleveland, one of the most flourishing and prosperous of class journals, if one may judge from its advertising columns, at the beginning of the present year came out with a new and very suggestive heading. As a purveyor of industrial intelligence, the *Review* is second to no other journal in the country.

A SPAN of iron bridge at Kansas City, lately built by the Detroit Bridge and Iron Company, for the Hannibal & St. Joseph Railroad, was tested with a moving load of about 163½ tons, uniformly distributed. Span 175 ft., width 20 ft. height of truss, 27 ft., number of panels 12 original camber two inches. Under the load the deflection at the center was 7⅛ inches, and at the quarters ½ inch. The load being removed, the bridge recovered its original curve.

THE large Cornish engines of the city water works, Louisville, Ky. have steam cylinders 70 inches in diameter and 10 feet stroke. They are double, each working a single acting lift and force pump, 36 inches diameter and 10 feet stroke. The extreme lift, when the river is at the lowest stage, is 21 feet 10 inches. The pump mains have a diameter of 40 inches to admit of the employment of 40-inch pumps, when needed. The highest daily duty was 48,363,344 lbs. of water raised one foot with 100 lbs. of coal; the highest monthly average was 35,957,629 lbs., and the yearly average duty 30,217,365 lbs. Cost of engines and connections complete, 117,753.64.

MR. CHARLES COLLINS, the late chief engineer of the Lake Shore & Michigan Southern Railroad, was born in Richmond, N. Y., in 1826, was educated at an Eastern college, and received his professional instruction at the Rensselaer Polytechnic Institute, Troy, N. Y. He worked for some years in New England, being at one time on the Boston & Albany R. R. He went to Ohio in 1849, took charge of the location of the C. C. C. & I. R. R., and was also employed on the construction. He was next superintendent of the Painesville & Ashtabula road, and, when the Lake Shore and Michigan Southern were consolidated, he was given his late position. During this time he was also more or less connected with some other lines.

THERE has been unusual activity in railroad construction in the State of Ohio. Most of the new lines have been local roads, many of them narrow gauge. The *Railroad Gazette* says that "The roads there seem to be constructed almost wholly from home capital, and largely by those who expect to use them; and this may be said of most of the roads of 1876, even in the newer States. They have been built because their projectors expected profits from their earnings, and not, as were many in 1873 and before, because the projectors expected profits from the work of constructing them." That is a very healthy condition of things, and will lead to a gradual and sound revival of that branch of engineering construction.

IT has been found that granite may be sawed into blocks or slabs, in the ordinary machine, by employing finely divided chilled iron in place of sand. A jet of steam is directed upon a fine stream of melted iron, blowing it into spray, which falls into cold water and is chilled. By using these globules under a saw of soft iron, granite can be sawn at the rate of three or four inches per hour, and for small blocks, where a short saw will bear heavy pressure without buckling, it is found possible to cut 12 or 14 inches per hour. The surface left takes a polish much more readily than does a hammered surface, as there are no bruised and shattered crystals to be ground away.

A chemist has proposed to preserve timber by tanning it with a compound of tannic acid and iron. The resistance of oak to decay has been ascribed to its tannin, and hence this process has been devised. The invention of injecting timber with tannate of protoxide of iron is due to M. Hatzfield; the Eastern Railway Company of France has experimented with it on sleepers. The wood is turned black. The lapse of time only will prove whether the process is worth anything or not. Boucherie, the well-known inventor of the sulphate of copper treatment, denies the efficacy of this new application, contending that salts of iron have yielded only partially successful results.

THE meetings of the Civil Engineer's Club of the Northwest are becoming more interesting each month; the number of members and visitors in attendance, and the subjects presented have largely increased, and with them the opportunities for acquaintance and interchange of opinions on various important undertakings. There is evidence of this same interest being manifested in the other Engineering societies of the country, and we consider it a sign of their recognition as being the nuclei around which the profession must gather in order to concentrate its influence and make itself felt as the great civilizing power in society, and the agency for carrying out those wonderful public improvements which are the marvel and boast of the present century. It is not an easy matter at first sight for engineers to see the utility of these associations, at the meetings of which they may never find it convenient to be in attendance, but if we look at the mass of valuable information that has already been given to the world by the leading Engineering societies of Europe and America, and the opportunities for the discussion of subjects pertaining to the benefit of every member of the profession, besides the many important investigations which they have been instrumental in promoting, we cannot but feel certain that American engineers will very soon see the merit of massing their forces under the leadership of these societies.

This subject of societies reminds us of the query of a correspondent, made some months since, as to whether an organization similar to that of the Engineers' Club might not be effected by the surveyors of this and adjoining States. We think the idea is a good one and very feasible, and we would like to see it carried out. There are a variety of subjects of general importance to both the public and the surveyors that need to be discussed to ensure intelligent action thereon, and we know of no better way than holding meetings at stated intervals for the purpose of a better acquaintance, and a personal interchange of opinions. The subjects might be previously arranged and circulated in printed form among members, so that all attending the meetings might come prepared to take an active part in the discussions. Local or district societies might be formed which would gradually extend over the whole country, holding monthly meetings, and from these clubs State societies might be constituted around which would crystallize the scattered influence of the local clubs, and which would bring together in an available shape the practice of the best surveyors in the State, so as to produce uniformity therein, and give it that sanction in legal proceedings that could not be overturned. This State Society, meeting once or twice a year, or even quarterly, would soon combine the best talent in the State and when any legislation was to be had, it would undoubtedly control it. By a combination of these societies, throughout the public land states, measures of reform in surveying practice can be organized and carried out that never can be otherwise, and the profession of surveying might be given a recognition that it never will attain to while it is practiced after the present isolated mode. Correspondence on the subject of Surveyors' Societies for any part of the Union will be in order and we will be pleased to give such as much of our available space as we can spare.

FROM the Annual Report of the city of Middletown, Conn., for the year ending January 1st, 1877, just received, we make the following extracts. The Mayor in his address says:—

"The question of 'how to do it' in relation to the Street Commissionership has been experimented upon for years by successive City Councils, and is not yet determined, though it has often resulted in illustrating to the satisfaction of our citizens 'how not to do it.' We would suggest that after electing a competent man for the position, that he be paid a living salary upon the inexorable condition that his time be devoted to the business of the Street Department and that exclusively, and not be allowed to engage in other occupation, neither upon *contracts* for individuals in city work nor for his personal benefit."

Also in relation to the sewerage "much expense has accrued to this department from the inefficient manner in which certain branches of our sewerage had been constructed under the original contract, which is the result of what was then bad faith, or gross negligence. To save our streets, this work had to be gone over again in the proper manner, and of course the expense followed."

The Street Committee evidently had a bad time of it as their Report is a series of groans over the total depravity of human nature by which their own labors and the city expenditures have been greatly increased in the past year.

The Sewer Committee, at the beginning of the year, "guessed" that the expenditures for sewers would fall

within one thousand dollars, which was just $4,409.35 out of the way, a result which was largely due to their being obliged to overhaul a great deal of dishonest work of former contractors and rebuild it at a largely increased cost.

The Engineers' Report refers mainly to the streets, of which 3010 lineal feet were graded, and 22,040 sq. feet of flagging laid; the total expenses were $11,474.55 of which $591.67 was salary of Commissioner and $303.90 was for engineering.

THE subject of heating street cars in cold weather has been attracting attention in several of the larger cities, and notably in New York. From the *City Record*, an official paper, we learn that the committee to whom the subject was referred has reported:

"That the subject so referred received the closest attention of your Committee, several meetings having been held, and all persons interested for and against the measure were afforded every possible facility to make their wishes known.

"At the outset, your Committee were induced to believe that the question was one of more than ordinary importance; that our entire community, at least that portion of it that used street cars in travelling to and from their places of business, or for other purposes, were unanimously in favor of compelling the several companies to heat their cars, and that but one sentiment pervaded our people, and that favorable to the proposition. In this, however they were greatly disappointed. At the meetings of your Committee but two classes of persons appeared: One, the officers of the several companies; the other, inventors of apparatus for heating the cars. Both classes were directly and pecuniarily interested. Not one disinterested person, not one citizen other than those above referred to, appeared before your Committee in advocacy or in opposition to the measure.

"From this it is clear to your Committee that the general public are totally indifferent, and care not what action your Committee take in the premises. Indeed, from inquiries made by your Committee, of persons who daily use the cars, they are convinced that the travelling public are averse to the measure, being apprehensive that a crowded car, overheated by artificial means, in addition to the natural heat or warmth of the body, would superinduce disease, and that the seeming comfort of a heated car would be more than offset by the fear of contracting disease.

"Your Committee, therefore, are of the opinion that it is not advisable, at this time, at least, to exercise the power, and compel the heating of the city railroad cars. So many contingencies connected with the health of the passengers constantly present themselves to the minds of your Committee, that they believe the question can be with safety left to the care of those charged directly with the preservation of the health of the public.

"One or two regulations connected with the running of the city railroad cars, however, can, with advantage to the public, be insisted on. The front door of every car should be securely fastened, and never opened from the time the car starts until it reaches its destination; clean straw should be provided every day, for the bottom of every car, and the ventilation should be so arranged that impure air could be permitted to escape from the car by some arrangement that will at the same time prevent the admission of cold air."

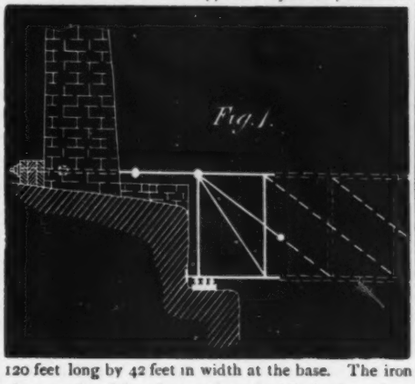
A minority report, however, asks that the experiment of heating be tried on ten per cent. of the cars running in New York city so that intelligent action may be taken hereafter in the matter.

THE KENTUCKY RIVER BRIDGE.

About twenty-three yerrs ago, the late John A. Roebling commenced a work which, if completed, would have been the crowning triumph of his life. It was a railroad suspension bridge of 1,236 ft. span, crossing the canon of the Kentucky river 275 feet above the bottom of the gorge. The towers were built and the anchorages finished, but at this stage of the work the railroad company failed. Roebling was stopped, and until the engineers of the Cincinnati Southern railway decided that no better crossing than Roebling's location could be found, the giant piers stood in a deserted wilderness, a monument to the financial crash of 1857.

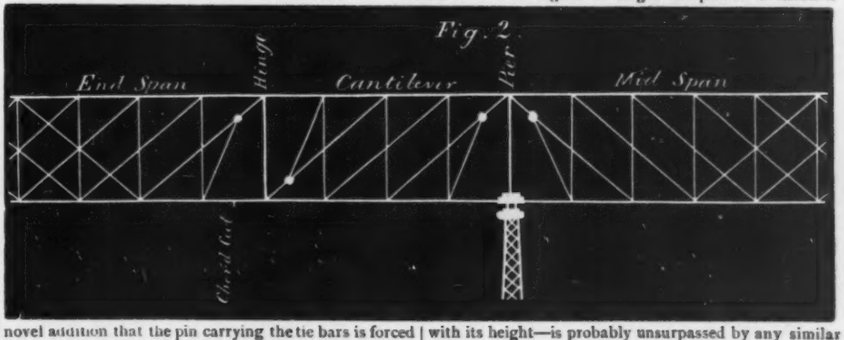
When Cincinnati decided to build a railroad to Chattanooga, the gorge of the Kentucky was found to be one of the worst obstacles on the route; and when bids on this crossing were called for, each competitor was required to make up his own plan for the entire structure, which plan it was obligatory should meet the difficulties attendant upon the following conditions of the case: First, the erection of a structure over a chasm 275 feet deep; next, in connection with this fact that the rise and fall of the river was 55 feet, and that it had been known to rise 40 feet in a single night, and generally averaged a flood every two months. Lastly, the river makes a bend just under the bridge, which renders its passage by steamers and rafts too hazardous to permit of the erection of a pier in the waterway.

A number of meritorious plans were presented, but the one finally accepted was that prepared by Mr. Shaler Smith, of the Baltimore Bridge Company. The viaduct as now being constructed, consists of three spans, of 375 feet each, resting on the bluffs and on two iron piers, which latter in turn are supported by stone piers, each



120 feet long by 42 feet in width at the base. The iron piers consist of four legs each, and while having a base of 71 ft. 6 in., by 28 ft., their longitudinal profile terminates in a point at the top, or rather in a 12-inch pin, upon which the truss rests as on a rocker. The entire pier is a complete structure within itself, and can be rolled about on the masonry, the pedestals resting on double roller beds for this purpose.

The truss itself is, during erection, a continuous girder, of the Whipple type; but after erection it will be converted into one continuous girder, 525 feet long, projecting at each end 75 feet over its points of support, and carrying from each of these cantilevers a 300-feet span, which bridges the distance from the end of the cantilever to the bluff. It was necessary to make the bridge a continuous girder in order to raise it without false work; and the hinges were obligatory because the rise and fall of the piers from thermal changes will amount to fully two inches, and would vary the strains hourly, in a true continuous truss. The truss is 37.5 ft. deep, and 18-ft. wide, and each bay is divided into 20 panels of 18.7 ft. each. All connections between ties, posts and chords are hinged on pin connections, but the chords are riveted to each other throughout, with the



novel addition that the pin carrying the tie bars is forced into the chord splice by hydraulic pressure, and thus does duty as a rivet. It will be seen that the details combine both the American principles of pin joints and of massing the materials in approved shapes along the lines of strain, together with the European practice of continuous riveted chords, fitted to resist both tension and compression. This peculiar mode of construction was adopted in order to erect the truss in the manner which we are now about to describe.

After the bridge seat was cut out of the cliffs, the end posts were set up, and the first section of bottom chord laid in place, each chord being continued back to the rock by a large screw-jack placed between its rear and the face of the bluff. Then the top of each end post was bolted back to Roebling's towers by anchor bolts, which had a screw adjustment. From this point the end or main tie was carried to the bottom chord at the foot of the second post, and then post No. 2 and the first panel of top chord were put in place. When the first panel was in position, the work looked as shown in Fig. 1. It will readily be seen that with these connections once made, the structure could be built out, panel by panel, until the limit of strength of the anchorage bolts, or of the top chord, or the available resistance of the Roebling towers had been reached. This last was the governing factor, and the other parts were proportioned to suit. Accordingly, as the truss grew out from the face of the bluff, a temporary wooden tower sprang up from the bottom of the valley to meet it, the center of the tower being 196 ft.

The next flight was to the permanent pier, 178 ft. 2 in. When the span left the bluff the iron pier was started upward from the masonry, and the two met in mid-air, the working forces on each arriving at the point of junction within two hours of each other. The weather was cold, and the span was short, owing to the compression of the lower chord and the effect of temperature; but this had been foreseen, and the huge pier, weighing 400,000 lbs. was moved on its rollers towards the span until the pier which connects the two could be put in place. This done, the truss was built out as before until the middle of the river was reached, which completed the work from the north side. In the meantime the temporary wooden tower had been taken down, and at this present writing the same process just described is going on, but from the south side of the river.

When the two halves of the bridge meet, in the centre of the middle span, the two projecting half-spans will be adjusted to the same level by loading the shore spans, and the connecting sections of chord put in place. The last operation will consist in taking out the bottom chord pins in the fourth panel north and south of each pier in the shore spans, thus hinging these two spans and fixing arbitrarily and without ambiguity the strains in all parts of the truss. In order that there may be no doubtful action at the hinging points, both web systems are concentrated into one in the two panels adjoining the post at which the chord is cut, as shown in fig 2.

This is also done in the end panels of each span in order to concentrate the shearing strains more conveniently. In erecting this bridge the most important points for computation were: first, the angle to be given the span at starting so as to land properly on the wooden pier, and, next, the correct elevation to be given to the truss at the wooden tower so that an exact junction could be made with the pin on the top of the permanent iron pier. These operations were both successful.

Altogether, in the novelties introduced in both construction and erection, and in strict adherence to theory throughout, this great viaduct—the most important in the world in regard to length of span in connection with its height—is probably unsurpassed by any similar work now existing. When it is completed, we hope to publish a plate and full description.

The engineers who decided upon Mr. Shaler Smith's design as the best were Mr. Thomas D. Lovett, then Consulting Engineer of the Cincinnati Southern, and Mr. G. Bouscaren, who has since succeeded him in that position. The iron work was all done by the Edgemoor Iron Company, and it was watched and inspected from the rolling mill pile to the finished bridge, pieces being tested out of every plate used. The modulus of elasticity was obtained for every individual eye-bar, and the bars were paired together according to their moduli. Messrs. C. C. Wrenshall, Charles Houser and Michael Walsh are the superintendents in charge of the erection, and the engineers on the part of the railroad company are Messrs. Rudolph Weiser, Charles Lasker and Chas. Bates. The erection was begun Oct. 16 and will probably be completed about Feb. 20. There are 2,855,000 lbs. of iron in the spans, and 793,000 lbs. in the piers and the amount of masonry is 12,915 cubic yards. The spans have iron stringers as well as floor beams.—*Railroad Gazette.*

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 72d regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on the 6th of February, beginning at 4 P. M.

The President, Mr. E. Chesbrough, occupied the chair.

The minutes of the January meeting having been read and approved, Mr. L. P. Morehouse, the Secretary, reported the receipt from Colonel Farquhar, U. S. A., of St. Paul, of the "Annual report upon the preservation of the Falls of St. Anthony, and the improvement of the Mississippi and Minnesota Rivers," and the "annual report upon the improvement of the Lake Superior Harbors."

The receipts of documents from General A. A. Humphreys, Chief of Engineers, U. S. A., published by the War Department, on "Internal Improvements" was also acknowledged. A vote of thanks was then given to the donors.

Mr. W. B. Rice exhibited a new pontoon draw-bridge, and explained briefly the workings of the same.

Mr. F. W. Clarke contributed and read the paper for the evening upon the "Artificial Drainage of the Calumet Marshes."*

Mr. J. M. Emmerson exhibited a model of a floating lighthouse, by the late Capt. Moody of London. He gave a very interesting account of its history and also the experiments already tried with it, both its adaptability for the purposes of a lighthouse, and as built for a floating battery.

The meeting then adjourned.

CIVIL ENGINEERS' CLUB OF ST. LOUIS.

The one hundred and seventy-third meeting of the Civil Engineers' Club of St. Louis, was held January 24th, 1877, at Washington University, St. Louis. Meeting called to order by the President. Minutes of last meeting read and approved. Secretary reported progress in the matter of preparing Dr. Kluepfel's paper for publication.

Mr. Robert Moore then read a paper on "Force and Momentum," being a criticism on an article by Prof. De Volson Wood in the January number of Van Nostrand's Engineering Magazine. Moved, the thanks of the Club to Mr. Moore for his able and instructive paper.

Prof. Woodward then read extracts from a report on bridging the Mississippi at St. Louis, by Chas. Ellet, Jr., published in Philadelphia, in 1840. The Club then examined one of Crooke's radiometers, which belonged to the University. On motion adjourned.

CORRESPONDENCE.

HENDERSON, KY., *Feb. 3rd, 1877.*

EDITOR ENGINEERING NEWS:

SIR:—In reference to the subject of correspondence of X, in No. 3 of this volume, the reason why the pump failed to draw water, was owing to one or the other, or probably both, of two causes. First, that the suction pipe received air somewhere along its length; and second, that the pump was in an imperfect condition. For should the pipe have been tight and the pump in good condition, the water must surely have continued to flow; though it is to be borne in mind, that the velocity of the pump should only have been such as to have accommodated its displacement to the retarded flow of the water through so long and small a suction pipe. In practice, however, it is hardly to be expected that such perfect conditions could well exist, or could be maintained under the circumstances as to give satisfactory results. A.

—We regret to find Gov. Robinson lending his countenance to a movement designed to abolish the State survey established last year, a bill for that purpose having been introduced at Albany. We are the more surprised because the advantages of the survey are not in question, while the urgency of it is placed beyond all doubt by the Report of the Commissioners transmitted to the Legislature last month. That the wealthiest and most populous State of the Union, and one of the oldest, has never been surveyed "since the pioneer surveyors ran their compass lines through the woods, without taking into consideration the ever-changing variation of the magnetic needle, and measured the distances with chains of unknown lengths," seems incredible enough; but it is not half so incredible, nor, to speak plainly, half so disgraceful, as that any State official should desire to interrupt for a single day the geodetic labors already so auspiciously begun. Mr. James T. Gardner, the director of the Survey, reports a simply deplorable condition of local surveys, county boundaries and landmarks, and vast popular ignorance of the topography of the State. Examining the boundaries of eleven counties, he found only two out of more than sixty corners marked with any authentic monuments. In the western part of New York important lines were made the centres of the roads, but the shifting of fences has since then rendered the exact centre indeterminable, and has brought uncertainty and confusion into the local surveys based upon it. Trees, stakes, and other perishable landmarks having become obliterated, the only dependence of litigants is upon the recollection of the oldest inhabitants. Adjacent towns, in doubt as to their common boundary, often compel a railroad to pay double taxes on the same piece of track. As for the construction of railroads, "there is ample proof," says Mr. Gardner, "that if the people of the State had possessed a topographical map such as any European country has, the impracticability of running the Oswego Midland Railroad could and would have been clearly demonstrated before the building of the road, and $20,000,000 saved to the people of the State." Our best maps, however, contain errors like these: Albany placed about a mile from its true position, Hamilton College two miles, Ogdensburgh half a mile, Syracuse one and a half, Elmira two to three, Buffalo and Plattsburgh three. And these maps are very dear! It seems, however, a waste of time to adduce proofs of the crying need of an authoritative triangulation of the State, connected with that of the Coast Survey already executed in the valley of the Hudson. Mr. Gardner estimates that in ten years, at $20,000 a year, the whole State can be furnished with Survey stations that will last for ever. Will anybody deny that the State could better divert $200,000 from its unfinished Capitol than grudge the money to this indispensable work?—*The Nation.*

*This paper is printed in full on page 41.

THE UTILIZATION OF FURNACE-GAS.*

BY GUSTAV KLUEPFEL

In every furnace, where smelting material and fuel are charged in alternate layers, the inevitable consequence is, that the escaping gas contains a certain quantity of carbonic oxide, because the immediate product of combustion, carbonic acid, meets, on its way through the furnace, the carbon of the fuel at such a temperature, that it must unite with it and form carbonic oxide. This chemical truth can also be expressed in the following words: In furnaces of the character mentioned, it is theoretically impossible to make use of all the available heating effect of the fuel, the difference being contained in the escaping gas.

Mr. I. Lowthian Bell, in one of his latest papers, read before the English Iron and Steel Institute, states in detail that even in the most complete and best conducted blast furnaces of the Cleveland district of England, a little more than one-half the available heat condensed in a blast-furnace is contained in the escaping gases. But in most cases the latter proportion is much larger.

Happily for the production of pig iron, there is a demand for fuel outside of the furnace, which can be supplied by the escaping gas. This demand is so great, that, as Mr. Bell states in that same paper, those furnaces which retain not more than one-half of the available heat in their gases, are obliged to use the most improved apparatus for generating and supplying steam, to supply their need. But generally the proportion is such, that the supply is much greater than the demand. This is particularly the case where the fuel is partly or altogether raw coal.

It is but a short time since all the heating force contained in the escaping gas was a dead loss, as steam-engines and hot blast stoves were heated with coal; but even now that almost every blast furnace uses furnace gas, there is seldom much care taken in the utilization of this gas, and very often the greater part of it is lost before entering the place where it is wanted. Little can be said against this practice, where the supply of furnace gas is really much greater than needed. But the fact is, that almost invariably the gas is scarce, if the furnace itself is conducted with care and with the aim of saving fuel.

In the last ten years much progress has been made in reducing the amount of fuel used in the furnace itself, and to effect that progress a great amount of capital has been spent, particularly in making the blast furnaces higher, and by building expensive hot blast stoves. The consequence of these improvements has been in the first place, that a greater pressure of the blast has been found necessary, and therefore also a greater amount of steam was needed; in the second place, the hot blast stoves have got a greater surface, and therefore they needed more heating. All these improvements have augmented the amount of fuel required outside of the furnace, which makes it plain, that the very furnaces which are not advanced in their metallurgical standard, complain about scarcity of furnace gas, and have to burn coal in addition.

To avoid the latter expense a good many improvements in different modern furnace plants have been made. In the first place, the constructors of machinery for blast furnaces have tried to reduce the amount of steam needed for the blowing engine, and the most modern blast furnaces, in Grmany and Belgium especially, derived much advantage from the use of the best kind of condensing engines. At the same time, boilers of more complicated and effective types, have been put in operation, and the use of superheated steam introduced with some advantage. But all these improvements have been made at the cost of simplicity, so desirable in work of that kind, where water is very impure, and where no stoppage is permissible.

A second kind of improvement has resulted from the study of the combustion of the furnace gas. Even the richest furnace gas consists of only about one-fourth by weight of carbonic oxide, and especially if it contains a good deal of moisture, there is some difficulty in burning all the gas introduced into the hot blast or into the boiler stove. Now it is true, that regarding hot blast stoves, the practice of introducing gas is, as a rule, much better in American than in the majority of European works, because the gas here is always burned in a very solid combustion chamber, where the heat is so intense that no particle of the gas can pass unburned. As for boiler stoves it is clear that the same principle can be applied, yet it is seldom done. In the Meier Iron Works, combustion chambers have been built in front of the boilers, and the air for burning the gas is first heated by passing through flues made in the side walls of said chambers.

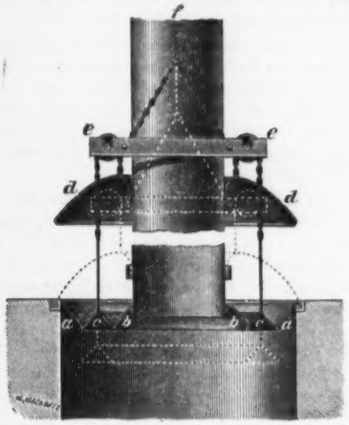
Another great loss of heat is caused by the hot blast stoves of whatever construction they may be. The stoves supplied with iron pipes lose the larger part of the heat they receive through the chimneys; in the Whitwell stoves this loss is avoided, the temperature of the escaping gas being no more than 200° Centigrade, but in using these stoves a considerable loss takes place by the radiation of the very large external surface. In case this loss should prove injurious, I propose to cover the whole surface of the stoves with a thin layer of slag-wool, which could easily be secured by means of wooden slats fastened by wire.

The improvements spoken of all relate to the better utilization of the gas conducted to the several places of combustion. But there is another possibility of saving which has received until recently very little attention on the part of ironmasters. I refer to the loss of gas escaping during the time of charging the furnace, which is very considerable in modern blast furnaces, where the number of charges is now much greater than it used to be a few years ago, and where on account of economy of labor one man has to do all the filling work, and therefore the furnace is open about half the time. Aware of that fact I considered the introduction of the charging apparatus of Weimer & Birkinbine, which was exhibited in full size at the Philadelphia Exposition as a great improvement. In this apparatus the cup and cone applied in the usual way are covered by a cast iron bell, in which openings appear by means of a rotation of the bell. Therefore, whenever a blast-furnace is built to fit a cup and cone apparatus, I would strongly recommend Weimer & Birkinbine's improvement. But there are objections to the cup and cone, at least for a new furnace, which according to the latest theory and experience should be built with a wide top in order to have as much contents as possible. For such a furnace the cup and cone as well as the covering bell would become uncommonly heavy and expensive, or if made smaller the distribution of the charge would not

* A paper read before the Engineers' Club of St. Louis, Dec. 6th, 1876.

be done in the best way. Besides that much can be said in favor of a wide perpendicular pipe as the first receiver of the gas, which makes the dust carried along fall down into the furnace. Taking this in consideration I designed for the blast-furnace of the Meier Iron Company the charging apparatus shown in the accompanying sketch.

The receiving pipe in the centre of the furnace top is supported by two inclined pipes, resting upon the platform. The cone *a a*, made of boiler iron and stiffened



with angle iron is fixed to the furnace wall and a similar cone *b b* is fixed to the receiving pipe, both made in sections in such a way that they can be gradually removed if worn out. The conical ring *c c*, also made in sections, is suspended by four chains, terminating on one end in gas pipes a little thicker than the chain and on the other connected with the sheet iron bell *d d*. Those chains rest upon four pulleys fixed in a frame *e e*, which is suspended on both sides of the central receiving pipe from one end of a double plate iron lever *f*, whose further end is controlled by a rod connected to a hydraulic piston below, which can be managed from above. The weight of the bell *d d* is regulated in such a manner, that it balances not only the weight of the conical ring *c c* but also the weight of that part of the charge, which rests upon that ring. Now, when the frame *e e* attains its highest position, the furnace is closed by the ring *c c* and the charge can be made and equally distributed without haste and without the least loss of gas, after which the valve of the hydraulic apparatus is opened, the bell descends leaving the furnace closed by the conical ring *c c* until the bell reaches the platform, when its weight is taken up and the conical ring descends further until the frame *e e* has reached its lowest point and the charge falls into the furnace during which time the furnace is closed by the bell. Reversing the process the bell cannnot rise until the ring *c c* has closed the furnace.

In that way we have a self-acting double closed top, which in whatever position prevents the gas from escaping. At the same time the filler can take his time and it can easily be seen, whether he distributes the charge equally all round as he ought. The charges will get a conchoidal shape, deeper in the centre and higher on the circumference. This will help to a more equal distribution of the gases through the furnace, because without such a precaution they are inclined to pass faster near the walls than in the centre of the furnace. Another advantage of this apparatus will be, that there are no horizontal flues, or gas-pipes where dust could accumulate.

SURVEY OF THE PUBLIC LANDS—HOW TO TELL TOWNSHIP AND SECTION CORNERS.*

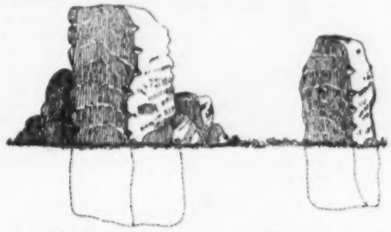
(*Concluded from page 34.*)

From quarter section and meander corners two bearing trees are to be marked, one within each of the adjoining sections.

Where the requisite number of "bearing trees" is not to be found at convenient and suitable distances, such as are found are to be marked as herein directed but in all such cases of deficiency in the number of bearing trees (unless, indeed, the boundary itself be *a tree*), a *quadrangular trench*, with sides of *five* feet, and with the angles to the cardinal points, must be spaded up outside the corner, as a center, and the earth carefully thrown on the inside, so as to form a range of earth, which will become covered with grass, and present a small square elevation, which in after-time will serve to mark unmistakably the spot of the corner.

CORNER STONES.

Where it is deemed best to use STONES for boundaries, in lieu of posts, you may, at *any* corner, insert endwise into the ground, to the depth of 7 or 8 inches, a stone, the number of cubic inches in which shall not be less than the number contained in a stone 14 inches long, 12 inches wide, and 3 inches thick—equal to 504 cubic inches—the edges of which must be set north and south, on north and south lines, and east and west, on east and west lines; the dimensions of each stone to be given in the field-notes at the time of establishing the corner The kind of stone should also be stated.



TOWNSHIP CORNER STONE. SECTION CORNER STONE.

MARKING CORNER STONES.

Stones at township corners, common to four townships, must have *six* notches, cut with a pick or chisel on each edge or side toward the cardinal points; and where used as section corners on the range and township lines, or as section corners in the interior of a township, they will also be notched, to correspond with the directions given for notching posts similarly situated.

Posts or stones at township corners on the base and standard lines, and which are common to two townships on the north side thereof, will have *six* notches on each of the *west*, *north*, and *east* sides or edges; and where such stones or posts are set for corners to two townships *south* of the base or standard, *six* notches will be cut on each of the west, *south* and east sides or edges.

Stones when used for quarter section corners, will have ¼ cut on them—on the west side on north and south lines, and on the north side east and west lines.

QUARTER SECTION CORNER STONE. SECTION CORNER.

MOUNDS.

Whenever bearing trees are not found, mounds of earth, or stone, are to be raised *around posts* on which the corners are to be marked in the manner aforesaid. Wherever a mound of earth is adopted, the same will present a conical shape; but at its base, on the earth's surface, a *quadrangular trench* will be dug; by the "trench" (here meant) is to be understood a *spade deep* of earth thrown up from the four sides of the line, *outside* the trench, so as to form a *continuous elevation along its outer edge*. In mounds of earth common to *four* townships or to *four* sections, they will present the *angles* of the quadrangular trench (*diagonally*) towards the cardinal points. In mounds common only to *two* townships or *two* sections, the *sides* of the quadrangular trench will *face* the cardinal points. The sides of the quadrangular trench at the base of a township mound are to be *six* feet, the height of mound *three* feet.

At section, quarter-section, and meander corners, the sides of the quadrangular trench at base of mounds are to be *five* feet, and the conical height *two and a half feet*.

Prior to piling up the earth to construct a mound, there is to be dug a spadeful or two of earth from the corner boundary point, and in the cavity so formed is to be deposited a *marked stone* or a portion of *charcoal* (the quantity whereof is to be noted in the field-book); or in lieu of charcoal or marked stone, a *charred stake* is to be driven twelve inches down into such center point; either of those will be a *witness* for the future, and whichever is adopted, the fact is to be noted in the field-book.

When mounds are formed of *earth*, the spot from where the earth is taken is called the "*pit*," the center of which ought to be wherever practicable, at a uniform distance and in a uniform direction from the center of the mound. There is to be a "pit" on *each* side of every mound, distant eighteen inches outside of the trench. The trench may be expected hereafter to be covered by tufts of grass, and thus to indicate the place of the mound, when the mound itself may have become obliterated by time or accident.

At meander corners the "pit" is to be directly on the line, *eight links* further from the water than the mound. Wherever necessity is found for deviating from these rules in respect to the "pits," the course and distance to each is to be stated in the field-books.

Perpetuity in the mound is a great desideratum. In forming it with light alluvial soil, the surveyor may find it necessary to make due allowance for the future settling of the earth, and thus making the mound more elevated than would be necessary in a more compact and tenacious soil, and increasing the base of it. In so doing, the relative proportions between the township mound and other mounds is to be reserv d as nearly as may be.

The earth is to be pressed down with the shovel during the process of piling it up. Mounds are to be *covered* with sod, grass side up, where sod is to be had; but, in forming a mound, *sod* is NEVER to be *wrought up* with the earth, because sod decays, and in the process of decomposing it will cause the mound to become porous, and therefore liable to premature destruction.

POSTS IN MOUNDS

must show above the top of the mound ten or twelve inches, and be notched and marked precisely as they would be for the same corner, without the mound.

MOUND MEMORIALS.

Besides the *charcoal*, marked *stone* or *charred stake*, one or the other of which must be lodged in the earth at the point of the corner, the deputy surveyor is recommended to plant *midway* between each pit and the trench, seeds of some tree (those of fruit trees adapted to the climate being always to be preferred), so that, in course of time should such take root, a small clump of trees may possibly hereafter note the place of the corner. The facts of planting such seed, and the kind thereof, are matters to be truthfully noted in the field-book.

WITNESS MOUNDS TO TOWNSHIP OR SECTION CORNERS.

If a township or section corner, in a situation where bearing or witness trees are not found within a reasonable distance therefrom, shall fall within a ravine, or in any other situation where the nature of the ground, or the circumstances of the locality, shall be such as may prevent or prove unfavorable to the erection of a mound, you will perpetuate such corner by selecting in the immediate vicinity thereof, a suitable plot of ground as a site for a bearing or *witness mound*, and erect thereon a mound of earth in the same manner and conditioned in every respect with *charcaal*, *stone*, or *charred stake* deposited beneath, as before directed; and measure and state in your field-book the distance and course from the position of the true corner of the bearing or witness mound so placed and erected.

DOUBLE CORNERS.

Such corners are to be nowhere except on the base and standard lines, whereon are to appear both the corners which mask the intersections of the lines which close thereon and those from which the surveys start on the north. On these lines, and at the time of running the same, the township section and quarter-section corners are to be planted, and each of these is a corner common to *two* (whether township or section corners), on the north side of the line and must be so marked.

The corners which are established on the standard at the times of running it, are to be known as "*standard corners*," and in addition to all the *ordinary corners* (as herein prescribed), they will be marked with the letters S. C. Closing corners will be marked with the letters C. C., in addition to other marks.

You will recollect that the corners (whether township or sectional corners), which are *common* to *two* (two townships or two sections), are not to be planted *diagonally*, like those which are common to *four*, but with the flat sides facing the cardinal points, and, on which the marks and notches are made as usual. This, it will be perceived, will serve yet more fully to distinguish the standard parallels from all other lines.

By instructions to surveyor-general, dated June 1, 1864, the Surveying Manual was modified in the following particulars, to wit?

POSTS IN MOUNDS.

All posts in mounds will hereafter be planted or driven into the ground to the depth of twelve inches, at the precise corner point; and the charcoal charred stake, or marked stone required in the Manual will be deposited twelve inches below the surface, against the north side of the post when the deputy is running north, and against the west side when the deputy is running west, etc.

Township mounds will be five feet in diameter at their base, and two and a half feet in perpendicular height. Posts in township mounds are therefore required to be four and a half feet in length, so as to allow twelve inches to project above the mound.

The planting of seeds between the pits and trenches as directed on page 11 of the Manual, is not required.

PITS IN LIEU OF TRENCHES.

The quadrangular trench required in connection with the construction of mounds is dispensed with. The *pits* will be continued, and should be of uniform dimensions. The pits for a township mound will be eighteen inches wide, two feet in length, and at least twelve inches deep, located six feet from the post. At section corners the pits will be eighteen inches *square*, and not less than twelve inches in depth.

At township corners common to *four* townships, the pits will be dug on the lines and lengthwise to them. On base and standard lines, where the corners are common to only *two* townships or sections, three pits only will be dug—two in line on either side of the post, and

* From Copp's Land Owner.

one on the line north or south of the corner, as the case may be. By this means the standard and closing corners will be readily distinguished from each other.

NOTCHING SECTION CORNER POSTS.

Posts or stones at the corners of sections in the interior of townships will have as many notches on the *south* and *east* edges as they are miles from the south and east boundaries of the township, instead of being notched on all four edges as directed in the Manual.

BEARING TREES.

Where a tree not less than two and a half inches in diameter can be found for a bearing tree within 300 links of the corner, it should be preferred to the trench or pit. The *quadrangular trench* required in the Manual as a substitute, where the requisite number of "bearing trees" is not found, is dispensed with, and a *pit* two feet square and not less than twelve inches deep is required in lieu thereof.

The following approved rules for the subdivision of sections are based upon the laws governing the survey of the public lands.

Under the provisions of the act of Congress approved February 11, 1805, the course to be pursued in the subdivision of sections, is to run straight lines from the established quarter-section corners—U. S. surveys—to the opposite corresponding corners and the point of intersection of lines so run, will be the corner common to the several quarter-sections, or, in other words, the legal center of the section.

In the subdivision of fractional sections, where no opposite corresponding corners have been or can be fixed, the subdivision lines should be ascertained by running from the established corners due north, south, east, or west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional section.

The law presupposes the section line surveyed and marked in the field by the U. S. deputy serveyors to be due north and south, or east and west lines, but in actual experience this is not always the case; hence, in order to carry out the spirit of the law, it will be necessary, in running subdivisional lines through fractional sections, to adopt mean courses where the section lines are not due lines, or to run the subdivision line parallel to the section line.

Upon the lines closing on the north and west boundaries of a township, the quarter-section corners are established by the U. S. deputy surveyors at precisely forty chains to the west or north of the last interior section corners and the excess or deficiency in the measurement is thrown on the outer tier of lots, as per act of Congress approved May 10, 1800.

In the subdivision of quarter-sections the quarter-quarter corners are to be placed at points equidistant between the section and quarter-section corners and between the quarter corners and the common centre of the section, *except* on the last half-mile of the lines closing on the north or west boundaries of a township, where they should be placed at twenty chains (original measurement) to the north or west to the quarter-section corner.

The subdivision lines of fractional quarter-sections should be run from points on the section lines, intermediate between the section and quarter-section corners, due north, south, east, or west to the lake, water-course, or reservation which renders such tracts fractional.

When there are double sets of section corners on township and range lines, the quarter corners for the sections south and east of the lines are not established in the field by the United States surveyors, but in subdividing such sections said quarter corners should be so placed as to suit the *calculations of the areas of the quarter sections adjoining the township boundaries*, as expressed upon the official plat, adopting a proportional measurement where the present measurement of the north or west boundaries of the sections differs from the original measurement.

RE-ESTABLISHMENT OF LOST CORNERS.

The original corners when they can be found, must stand as the true corners they were intended to represent, even though not exactly where strict professional care might have placed them in the first instance.

Missing corners should be re-established in the identical localities they originally occupied. When the point cannot be determined by the existing land-marks in the field resort must be had to the field notes of the original surveys. The law provides that the lengths of the lines as stated in the field-notes shall be considered as the true lengths thereof, and the distances between corners set down in the field-notes constitute proper data from which to determine the true locality of a missing corner; hence the rule that all such should be restored at distances proportionate to the original measurements between existing original corners. That is, if the measurement between two existing corners overruns or falls short of that stated in the field-notes, the excess or deficiency should be distributed proportionately among the intervening section lines between the said existing corners standing in their original places. As has been observed, no existing original corner can be disturbed, and it will be plain that any excess or deficiency in measurements between existing corners cannot in any degree affect the distances beyond said existing corners, but must be added or subtracted proportionately too or from the intervals embraced between the corners which are still standing.

IRON BRIDGES.

The selection of bridges should be governed by economy and adaptability to location, since no one of the well-recognized types of bridges is better than another. Apart from such motives *any* bridge designed on correct principles is a good one, whether a beam-truss, a suspension-truss, or a bowstring. On the contrary, any one is bad if improperly designed, and the principles of its construction ignorantly conceived. A general rule that will lead to satisfactory results is *to ignore any plan of bridge that can not be accurately analyzed as to the character and amount of strain occurring in all its parts*—such, for instance, as the Truesdell bridge, scores of which have been built during the last fifteen years; and assuming that the great majority are still in use, giving satisfaction to their users, yet their form of construction is one that removes them beyond the pale of the most refined analysis. They are purely empirical structures, and being such their construction should under no circumstances be permitted. It is bordering on criminality to build any structure on a plan that no human being can tell definitely any thing about, when there are so many plans that we thoroughly understand. —*Boller's Practical Treatise.*

RAILROAD NEWS.

Japan is to begin building interior lines of railroad this year.

The people of Eugene township, Vermillion county, Ind., have voted $16,000 to aid in extending the Frankfort & Kokomo road to the State line.

A bill has been introduced in Congress by Mr. Hubbell, chartering a freight railroad company from tide-water on the Atlantic to the Missouri river.

The Longview & Sabine Valley R. R. Co. has been organized in Texas to build a railroad from Longview southeastward. Work has already been begun.

A party of Northern capitalists are talking of building a road from Jacksonville, Fla., southeast to St. Augustine, on the coast. The distance is about forty miles.

A private road for carrying lumber is being built by Messrs. Barret & Roper, from North Landing, in Norfolk county, Va., to Mount Pleasant, seven miles.

Surveys have been commenced to extend the Otter Lake Branch of the Flint & Pere Marquette Railroad, Michigan, to Lexington, on the shore of Lake Huron.

It is proposed to build a narrow-gauge road from Dunleith, Ill., northward to La Crosse, Wis., about 150 miles, on the eastern or Wisconsin side of the Mississippi.

The Henderson & Overton R. R., from Henderson, Tex., northwest to Overton, on the International & Great Northern, is progressing, forty hands being engaged in track-laying.

Great activity prevails on the Wheeling & Lake Erie R. R., on Short creek and Piracy fork, where heavy cuts and tunnels are necessary. At Pine Hill work has commenced on a tunnel which is to be 550 feet long.

Preparations are making to extend the Chippewa Falls & Western road northeastward into Taylor county where it will connect with the Wisconsin Central road. Surveying is to commence immediately.

Track-laying on the Houston & Texas Central R. R. is now actively in progress on the extension of the Waco branch, from Waco northward. The first section of 10 miles, will, it is expected, be finished in February.

The Canada Southern railway had plans and estimates made for a tunnel through the limestone at their crossing at Grosse Isle. We have referred to that project more in detail in the NEWS, Vol. III, Nos. 20, 27, 30 and 53, where we also discussed the general subject.

State Railroad Commissioner Delano was in Chillicothe, Ohio, lately, inspecting the Valley railroad bridge at that point. The bridge shows no signs of weakness, but being a new structure it has been carefully watched. Some additional bracing has been ordered, so as to avoid all possibility of danger.

A company has been organized to build a branch railroad from the Jackson, Lansing & Saginaw R. R. to Alpena, Michigan, and a meeting of citizens of that city to favor the project has been held. The company want $50,000 from the city and a land grant from the State.

Brazil has now about twenty-five hundred miles of railroad in operation, of either the 5 ft. 3 in., or 39⅜ in. gauge, and the government is taking steps to increase the amount, having already decided to add some eleven hundred miles more.

The South Australian government proposes to spend $10,000,000 in constructing 400 miles of railway at once; New Zealand thinks of expending $6,250,000 for a similar purpose; and Tasmania and Victoria are also agitating the subject of railway grants.

The Canon City & Saguache R. R. Co. has been organized in Colorado to build a railroad from Canon City, the terminus of a branch of the Denver and Rio Grande, up the Arkansas, and through the valley of Pleasant Creek to Saguache, in the San Juan mining district. The capital stock is to be $1,000,000.

The permanent bridge of the Galveston, Harrisburg & San Antonio R. R. over the Guadaloupe is nearly finished, and it will be ready for use very soon. Track-laying is progressing steadily from the Cibolo towards San Antonio, and has nearly reached the Salado, where a bridge is being erected. This bridge may delay the track-layers for a few days.

Mr. C. F. Stephens, Chief Engineer of the Dallas & Wachita R. R., writes as follows under date of Jan. 24: "Track-laying is in progress. Five miles are down, and iron for 18 more is being rolled by the Kansas Mill Co. and shipped daily. Grading and bridging for 17 miles are down, the next six miles are under contract, exclusive of a bridge over Elm fork of Trinity river, and a party is in the field completing the location of the first 50 miles. The track is to be laid to Denton, the county seat of Denton county, and 40 miles from Dallas by July 1, and our charter compels 120 miles to be completed by Nov. 1. 1878. This will take us through the coal and copper fields, and open up the richest mineral country in the Southwest."

Now that public attention is so largely drawn to the subject of bridge building, by reason of the Ashtabula accident, it is not surprising that there is a continually increasing demand for such works as BOLLER'S IRON BRIDGES and "Greene's Graphical Analysis of Bridge Trusses." In both of these the information is conveyed in such plain terms that an intelligent idea of the different parts of the bridge, and the variety of trusses in most popular use is soon obtained, and the technical language which hitherto has conveyed rather indefinite ideas to the reader's mind is soon invested with new interest as each term is understood and the action of certain forces is perfectly comprehended.

NOTES.

The contract for timber for lock gates on the Lachine canal has been awarded to D. S. Booth, of Brockville, Ont. The amount of timber is nearly $200,000.

Mr. Glen affirms that iron can be profitably smelted at Whitby, Ont. The ore will come from Snowden, the limestone from Kingston, and the coal from Pennsylvania.

It is estimated that 10,000,000 acres of land in Algeria are covered with a spontaneous growth of the Alpha plant, the fibre of which is exported for the manufacture of paper work.

ONE great recommendation of BOLLER'S IRON BRIDGES is the popular style in which Part First is written—easy of comprehension to any man of average intelligence—while Part Second is "offered as an aid to Engineers not expert in this branch of the profession, and yet who are often called upon to act as inspectors."

During the past year th city of East Saginaw, Mich., has made extensive street and sewer improvements. There were 1,106 lineal feet of pavement—roadway 38 ft. wide—laid at a cost of $8,400, and 6⅓ miles of plank roadway, 8 ft. wide, at a cost of $6,475 for plank, and $1,019 for labor. The pavement consists of round yellow cedar blocks, cut eight inches in length, and laid on a foundation of sand four inches deep. The curbing consists of white oak four inches thick, and is laid generally in 16 feet lengths. The total length of public sewers in operation to date is about 5¾ miles of varying sizes, the largest being a brick sewer, 5 feet in diameter in the clear. Of private drains laid to sewers to date, there are about four miles.

AT a meeting of the special Committee on Water, of the New York Board of Aldermen, January 24, Gen. Viele stated that the present Croton aqueduct was in a dangerous condition and likely to burst at any moment. He also stated that additional storage reservoirs would give a sufficient supply of water, but would not increase the head. The only way to accomplish the latter result was to erect two or three force pumps in different parts of the city.

ARTIFICIAL DRAINAGE OF THE CALUMET MARSHES.*

Near large bodies of water there are often low lands, whose surface is either not high enough readily to shed rainfall, or so low as to be flooded by tides; these lands frequently become sufficiently valuable to attempt their redemption by artificial drainage. The first extensive system of artificial drainage was an attempt in 1634 to drain the low lands, some 400,000 acres in extent, adjacent to the river Ouse in England. The first attempt failed, but a second effort in 1649, reclaimed the lands, now known as the Bedford level.

Later, in 1839, the pumping engines at Harlem lake, in Holland, were erected to drain an area of 70 6-10ths square miles. These engines lifted 36 million tons of water per month, working from May, 1848, until July, 1852, to clear this area of water, averaging 12¾ feet in depth.

The pumping works at the Ferrara marshes in Italy, have been recently erected, draining the largest district ever concentrated in one system, which is 200 square miles in extent. These pumps are of the centrifugal pattern eight in number, capable of lifting 72,960 cubic feet of water per minute, or over 98 million tons per month.

Artificial drainage of such scope is unusual in the United Srates, and hitherto entirely unattempted in this vicinity. Measures are being taken, however, to drain a portion of the Calumet marshes, now known as South Chicago, situated within the corporate limits of the town of Hyde Park. This is the fruition of a scheme suggested twenty years ago by the late Stephen A. Douglas.

The plan described in this paper is not one for draining all the Calumet marsh, but the limits of the proposed drainage area include a small portion of that extensive territory of indistinguishable rivers, lakes and marsh which lies either side of the Illinois and Indiana boundary line. The ocean tides ebb and flow within fixed limits, seldom overpassed, but the surface of lake Michigan rises and falls in longer, irregular intervals, whose periods and amount cannot be foretold, but have been observed and registered. In 1847 the engineers of the Illinois & Michigan canal left a datum which was their estimate of extreme low water. The following statement shows the fluctuations of lake level since 1854, at which time the observations began:

Mean yearly elevation of surface of Lake Michigan, with reference to Chicago datnm, from 1854 to 1875 inclusive:

1854, 1.83; 1855, 1.56; 1856, 1.60;—1857, 2.42; 1858, 2.90; 1859, 2.98; 1860, 2.54; 1861 2,56; 1862, 2.50; 1863, 2,10;—1864. 1.57; 1865, 1.30; 1866, 1.07; 1867, 1.49; 1868, 1.01; 1869, 1.13; 1870, 2.09; 1871. 1.77; 1872, 0.81; 1873, 1.40; 1874, 1.67; 1875, 1.45;—for the first six months of 1876, 2.10.

In the past twelve years there has been a large amount of speculation and actual improvement in the vicinity of South Chicago; during this period the water in the lake has been at a low stage, averaging 1 28-100 ft. above datum. In 1876 the lake surface rose, and the ditches. previously adequate, no longer served to free the land from water. Their current, on the contrary, frequently set from the lake toward the interior of the country, and successive heavy rains accumulated water to a considerable depth over a thickly settled country. There was little trouble as long as the lake kept below a level of 1½ feet above datum, but a rise of over a foot—frequently augmented another foot, by northeast storms—placed a large territory below lake level.

The following is a brief abstract of the topography of the country: A large tract of low ground, varied at intervals by ridges, stretches from the lake westward, with slightly increasing elevation and rising in terraces, attains its maximum height of 90 feet in the Blue Island ridge. distant five miles from the lake. This ridge, two miles wide, and six miles long, an isolated mound of hard material, is cut off abruptly at its southern end by the Calumet creek, while its northern extremity gradually sinks to the plain.

Stony Island ridge, a rocky outcrop, rises abruptly above the marsh, within 1½ miles of the lake. The general trend is east and west, and by its connection at the western end with the high prairie, it divides the low ground lying north and south of it. For the present, only that portion of the low ground lying north of this ridge will be included in the drainage system, with the exception of a small tract lying southeast, on the opposite side of the Calumet river. South of Stony Island ridge is the large, shallow basin of the Calumet lake, bordered on all sides except the west, by a wide marsh, through which the Calumet river pursues a tortuous course.

The problem as presented to the engineer naturally assumes two divisions: First to keep out the waters of the lake; and second, to provide means of preventing the accumulation, and disposing of the rainfall. The problem of preventing inflow from the lake is almost entirely solved by natural defenses. A high, broad bank of sand follows the shore line, and various ridges stretching across the low lands only require to be connected by graded streets, a few feet high, to make the diking a complete protection on all sides. The sketch herewith presented may serve to indicate the topography of the area of low land into which the ridges stretch from various directions. The second division of the problem includes the greater range of calculation and forethought. There are two ways of providing for the rainfall, leaving the question of amount for future consideration. Reference to the map shows the high ground to have sufficient height to lead directly into the lake the rainfall which now flows to the low ground. To lessen the amount of water to be pumped, and to prevent floods over the low lands, it is necessary to devise a system of catch drains, which direct the water from the high ground into main ditches, leading over and across the low lands into lake Michigan, or emptying into lake Calumet.

By this system of catch drains, only the rain falling over the low ground would be pumped, and less powerful machinery and expense in maintenance would be needed. Tables of continued observation give annual, monthly, and daily rainfall. The maximum daily rainfall should determine the extreme ability of the pumping machinery. It is necessary to consider how much rainfall is evaporated, how much absorbed, or held suspended in the soil to find its way out by percolation, and, finally, what portion will be conveyed through ditches to the pumping station. The perfection of the system of ditches will regulate the rapidity of the accumulation of water. One inch rainfall in twenty-four hours is an amount ordinarily estimated, although this amount may fall in less than one hour. Supposing snow three feet in depth be followed by a warm rain, several days must elapse to melt this snow into its equivalent, three inches of water. The following table gives average annual rainfall in different parts of the United States:

Alabama and Louisiana	56"	Ohio	40"
Oregon	49"	New England	40"
Florida	48"	New York	37"
Virginia and Carolina	48"	Michigan and Wisconsin	32"
Tennessee and Kentucky	48"	Iowa and Kansas	31"
Georgia	44"	Texas	29"
Arkansas and Missouri	42"	California	18"
Maryland and Pennsylvania	41"	New Mexico	13"

*Paper read before the Civil Engineers' Club of the Northwest, Tuesday, February 6th, 1877, by Frederick Wilcox Clarke.

England has an average rainfall af 25", but the most startling instance is that in the vicinity of the Himalaya mountains, Asia, where 610", or over 50 feet of water falls in less than twelve months. For an accurate comprehension of the subject, it is requisite that the amounts of rain falling in different seasons should be carefully estimated. The average rainfall for this vicinity, taken from government observations since 1872, is 34 inches.

The rain of summer is greater than that of winter, including melted snow, being in the ratio of 3.55" average monthly rainfall to 1.93" for this locality, and is therefore nearly twice as much in the season when the ground is open to receive the rain and the warmth will soonest evaporate it. In calculating the amount of rainfall to be provided for within a given time, the retaining power of the ground must be estimated, as well as the maximum rainfall. A rainfall of one inch, spread over one day, amounts to 1,600 cubic feet per square mile per minute, not over one-quarter of which, it is expected, can be gathered at the pumping station. By referring to tables, including the last three years, the greatest daily rainfall will be found on Sept. 29 1875, amounting to nearly 3½"; the next, 2¼", occurred on July 27th, the same year. Both these rains fell in warm months and the water, percolating the soil, prepared by previous drainage, would reach the outlets gradually.

In the months when the ground is frozen the maximum rainfalls were 1 and 64-100 inches in March, and a day each in January and February of 1 ½ inches. It is reasonable to anticipate not over 2 inches in 24 hours during those months when the rainfalls of one day would reach the pumping station during the same interval. Two inches in 24 hours gives 3200 cubic feet per square mile, per minute. It is unfair, however to estimate that all the rainfall, of even the winter months will reach the pumping station; a large part will be held in hollows in the ground, and much contained in the ditches. Allowing 2 inches, as before stated, to fall in 24 hours, probably not more than one-fourth would reach the pumping station, and this would be distributed over at least two days.

Water which now accumulates in the limits of the low lands shown upon the topographical map, is largely rain which fell upon the higher prairie lands westward, outside the limits of Hyde Park. To divert this foreign water, if possible, is a point first to be considered. The low lands shown, have always been in the natural path of drainage for this outside area. As it may not be practicable to deny this foreign water a passage over Hyde Park, on its way to Lake Michigan, it is best to collect and transfer such water, by means of two main channels whose lines run directly eastward,using probably 79th and 87th streets for this purpose. These large drains are to have banks a few feet higher than the lowest ground through which they pass, keeping the water entirely within their channel, and all drains, connecting with the pumping station, are to be taken under them in culverts. While it is true, that perfecting the system of drains and ditches will more rapidly deliver rainfall to the pumps and tax their capacity, it is also true, that these drains and ditches will, in themselves, form a system of reservoirs in which the water can remain until pumped. This is entirely feasible as the low grounds are nearly level and the gradients of the ditches very slight. A large part of the land is subdivided into five acre blocks; supposing each block to be surrounded by a ditch, its length would be 1812 feet; allowing this ditch a width of 5 feet, and a depth of 2 feet, we have a reservoir capable of holding an inch rainfall over the entire five acres. Upon the basis of the foregoing calculations the Calumet pumping machinery was designed.

It consists of two centrifugal pumps whose respective capacity is 2200 and 4400 cubic feet of water, lifted 9 feet per minute. Having no large reservoir from which the pumps could draw a constant supply, it was deemed expedient to have a combination of pumping power that would be adapted to the varying amount of water accumulating at the pumping station. Each pump is driven by an upright non-condensing engine, adapted to work expansively and give a percentage of surplus power. The suction pipes of the pumps are 33 and 44 inches in diameter and their discharge pipes 24 and 32 inches diameter respectively. The suctions have an enlargement at the bottom provided with valves to retain the water when the pumps are stopped. The pumps draw water from separate chambers and gates, allowing either to be stopped and repaired while the other is working. The crank of the engines works off the end of the pump shaft. The engines are so designed as to give the requisite power with the number of revolutions required for the pumps. The boilers, three in number, are 4½ feet in diameter and 16 feet long; having thirty-nine 4-inch flues, and are connected above the domes by a steam drum. The engines and pump foundations are built in a caisson 30′ by 48′, sunk in an excavation to the blue clay, 14 feet below ordinary water. This caisson forms a pump well, guarded by two gates at the opening, for admission of water. Upon the walls of this caisson stands the enclosing brick building.

The main channel for the water will be crossed by a dam, opposite the pumping station, which serves to keep out the inflow from the Calumet river, and being provided with overflow gates gives egress to the water inside which might accumulate during severe or sudden freshets.

Estimating the drainage area at 20 square miles, the pumps have a capacity of 330 cubic feet per square mile per minute. The following comparison shows the pumping power provided in other instances. At the Ferrara marshes, Italy, the pumps dispose of 304 cubic feet of water per square mile per minute, or 1-125th of an inch rainfall per hour over the entire area, aggregating 69 inches rainfall per year.

The pumping works at Haarlem lakes, in Holland, pumped 425 cubic feet of water, per square mile per minute, or 1-88th inch rainfall per hour over the entire area, aggregating 98 inches total rainfall per year.

The processes of natural evaporation do not, to the ordinary observer, indicate any very great expenditure of force, yet, in reality the force equivalent of the rain supply over a hundred square miles alone for a single year is startling. It has been calculated that the amount of heat required to evaporate a quantity of water which would cover an area of 100 miles to the depth of an inch would equal the heat which would be produced by the combustion of half a million tons of coal. The amount of force of which this consumption of heat would be the equivalent corresponds to that which would be required to raise a weight of upwards of one thousand millions of tons to a height of one mile. But in comparing the natural means of evaporation and the mechanical means invented by man, the great advantage of the latter becomes at once apparent. Upon the basis of the foregoing calculation the coal consumed in evaporating an inch of rainfall over one square mile would amount to 5000 tons. Now an inch rainfall over one square mile amounts to 2,239,861 cubic feet or 140,000,000 pounds. If this be raised 6 feet it represents 840,000,000 foot-pounds. As many modern pumping engines show a duty of 60,000,000 foot-pounds for a hundred pounds of coal, the coal required to elevate an inch rainfall over one square mile would amount to less than three-fourths of a ton as against 5000 tons coal power exerted by the sun in evaporation.

There is no doubt that the future will see the problem of artificial drainage for these extended marshes solved on a grand scale in comparison with which the present scheme will seem an experiment, and that one of the numerous small lakes will be chosen as a receiving basin into which the entire district of about 40 miles will drain, thence being pumped into a channel leading into Lake Michigan.

ARCHES;

CONSIDERED GRAPHICALLY.

[Copyright 1877.]

(*Continued from page 30.*)

21. If the arched rib is fixed in direction at the ends (in place of being free to turn as previously supposed), by being firmly bolted to the abutments, or by having square ends, accurately bedded upon the skewbacks, a bending moment will generally exist at the points of support when the arch is loaded. By taking the piece of easily flexible wire before mentioned, clamping the ends firmly by two hand vises or otherwise, so as to fix the wire in the position of an arch, and then applying a load or the pressure of the finger, one can easily verify this statement for himself, and he will see that, for many positions of the load, the bending moment at one abutment is of the opposite kind to that at the other. The points at which the curve of equilibrium begins and ends will no longer be at A and B of Fig. 2, and some new conditions must be imposed, in order to determine these points.

22. Consider the effect of a single load upon the arched rib A C B of Fig. 4, which rib is fixed in direction at its ends. The curve of equilibrium will be two straight lines, and, as there may be bending at both points of support, it will be necessary to find the magnitudes of A I and B L, as well as of N G, three unknown quantities. Three conditions must therefore be satisfied.

Wm. Bell, C. E., in his paper "On the Stresses of Rigid Arches," etc., read before the Institution of Civil Engineers, of Great Britain, published in Vol. XXXIII of their transactions and reprinted in Van Nostrand's Engineering Magazine, Vol. VIII, March to May, 1873, and also Baker, in his book on "The Strengths of Beams, Columns and Arches," both writers treating the arch graphically, require but two conditions to be fulfilled for an arch with fixed ends. Such an assumption must be quite erroneous and must invalidate their results. Mr. Wilfred Airy, Associate of the Inst. of Civil Engineers, in his mathematical treatise on "Iron Arches," makes the same assumption in his analysis, which requires that the bending moment at the two abutments shall be the same. That this treatment cannot give correct results will be apparent, if we consider that a beam built in, or fixed, at its extremeties has different values for bending moments at the two ends, unless the load is symmetrical with regard to the middle of the span. If two conditions only are imposed, when three are necessary, many curves can be drawn, and the problem is left undetermined.

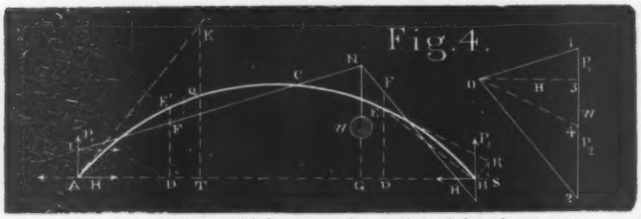


Fig. 4.

23. One condition which must be satisfied is plainly the one already used, § 11, that the change of span A B shall equal zero, or that

$$\Sigma E F . D E = 0 \qquad (4.)$$

Secondly:—As the *change of inclination* between any two contiguous points is directly proportional, in direction and magnitude, to the bending moment at that point (for the elongation and compression of the fibres on the two sides, upper and lower, of the rib result from this bending moment, and cause whatever change of direction or inclination the rib may take on at the point), and as the bending moment has been proved to be proportional simply to the ordinate E F, the increase of change of inclination at any point is proportional to the ordinate E F from that point of the rib to the curve of equilibrium.

The reader must distinguish between the change of inclination produced by flexure and the original inclination of the rib to the horizon at each point due to the curve to which it is constructed. If an arch is loaded it assumes a form slightly different from its shape when unloaded. The angle, at any particular point, between the two tangents to the curve of the rib, before and after it is loaded, is the *change of inclination* at that point.

Starting from A, the total change of inclination at C will be proportional to the sum of all the ordinates between A and C. On the other side of C, where the straight line crosses the rib, the bending moment being of the opposite kind, the changes of inclination will be in the opposite direction, and, in any summation of ordinates, for instance from A to E, must be subtracted. Then, as the end B is also fixed in its original direction, if we sum up all of the ordinates E F, from A to B, this sum must be zero. Therefore the second condition to be realized is that

$$\Sigma E F = 0, \qquad (6.)$$

or that *the sum of all the ordinates between the arch and the curve of equilibrium on the inside of the arch must equal the similar sum on the outside.*

24. Thirdly and finally:—It will be seen by Fig. 4, that, since the displacement B R of B, relatively to the point E, in case B could move, has been shown, by § 10, to be proportional to H. E F. E B, the vertical component of this displacement may, by a similar proportion to the one used in that section, be put as

$$S R = B R . \frac{D B}{E B};$$

therefore S R varies as $\frac{E B . H . E F . D B}{E B}$, or as H . E F. D B.

If the products E F. D B should be summed up for all points from A to Q, for example, we should get a quantity proportional to the vertical displacement of Q arising from the separate minute displacements between A and Q. If we pass beyond C, we have products with an opposite sign, and it then appears that, since the ends at A and B are fixed both in position and in direction, the sum of all the products between A and B must equal zero, or, since H cannot equal zero,

$$\Sigma E F . D B = 0. \qquad (7.)$$

Therefore the third and last condition is that *the sum of the products of each ordinate between the arch and the curve of equilibrium by its distance horizontally from one springing point must equal zero.* It is immaterial which springing is chosen, but all the D B's must be measured to the same abutment.

25. It will perhaps be expedient to dwell upon this equation a little longer, for the question will apparently arise why this condition is not also properly applicable to an arch which is jointed or hinged at the ends. Let a tangent A K be drawn to the rib at the point A, and a vertical line be dropped from it to the point Q. If the arch is now bent at the point E′, by a bending moment which is proportional to E′F, the point Q is moved a distance proportional to E′F multiplied by the distance from E′ to Q; but the distance which Q moves in the line Q K will be proportional to E′F multiplied by the horizontal projection of E′Q or D T, and similarly for moments at all other points between A and Q. As the tangent at A is fixed in direction in this case, the movement of Q away from the extremity of K Q, or its movement in relation to the tangent will be proportional to the summation of the E F's multiplied by the D T's; and therefore the distance of B from a tangent at A must be unchanged by any load, or its displacement must be zero, as above. In the case of the rib hinged at the ends the tangent at A changes in direction, and this condition cannot be applied. If, however, we should have an arch which was fixed at A and hinged at B, this condition would be necessary, and all the distances D B would be measured to the hinged end, while the second condition would not apply, and would not be needed.

This third condition was first applied to the determination of the bending moments in continuous bridges and pivot draw spans in "Graphical Analysis of Bridge Trusses,"* and so far as we are aware, is to be found nowhere else.

26. It will be seen that the arch of Fig. 4 is cut by the curve of equilibrium in three places, and it may be cut at four points, giving as many places of contraflexure. The areas on opposite sides of the rib represent bending moments of opposite kinds, and of which kind is readily known, if one remembers that the arch always moves from the curve of equilibrium. The amount of the weight, not being contained in any of the equations of condition, does not affect the position of the curve; for H is constant for all points of the arch for any given load, and, not being equal to zero, is thrown out of the equations. But the weight W does affect the value of H.

27. If 1-2 represents W, in the stress diagram of Fig. 4, and 1-0 and 2-0 are drawn parallel to N I and N L, 0-3, drawn horizontally, will determine the horizontal thrust H, while the load line will be divided at 3 into the two vertical components, P_1 and P_2, of the reactions, as marked. These vertical forces are not the same as would be obtained for the case previously considered, nor for a beam only supported at the ends. If we notice the arrows drawn at the abutment A, we see that, supposing P_1 were at first the fraction of W due to its position over G, or $\frac{G B}{A B}$ W, we have also at A, besides the horizontal thrust H, a couple H. A I. There is another couple at the other abutment, which may be of the same or opposite kinds; their algebraic sum can only be balanced by vertical forces at the two abutments acting with a lever arm of the span, and these vertical forces must either be taken from or added to the first supposed P_1 and P_2, bringing them to the amounts found by the stress diagram. The supposed supporting forces would be equal to the division of 1-2 made by a line drawn through 0, parallel to a line from I to L. The effect of the couple is the same as if P_1 had been calculated for the point where N I would meet the horizontal line.

The remarks on shear in § 20 apply equally well here. The direct compression in the rib at any point is obtained, as before, by drawing a line through 0 parallel to the tangent to the rib at the point in question. Thus the compression at E is 0-4.

*"Graphical Method for the Analysis of Bridge Trusses, extended to Continuous Girders and Draw Spans: Greene"; New York. D. Van Nostrand, Publisher. 1875.

(*To be continued.*)

OBSERVATIONS ON AMERICAN AND FOREIGN RAILWAYS.

In the year 1874, the government of Victoria sent Thos. Higinbotham, M. Inst. C. E., Engineer-in-chief of the Victoria Railways, on a tour of inspection of the public works of that class in the United States, Europe and India, so as to obtain for Australia the benefit of such knowledge as Mr. Higinbotham might thus acquire. He occupied the greater part of two years in the trip, and has embodied its results in a large octavo pamphlet of 72 pages, entitled "*Report of Observations on Railways made during a Tour in 1874 and 1875, undertaken by Direction of the Government of Victoria.*" We are indebted to Mr. E. S. Chesbrough, City Engineer of Chicago, for the opportunity of reading a copy sent him by Mr. Higinbotham, and from it we make some abstracts which may be of interest to our readers:

Mr. Higinbotham left Melbourne for San Francisco on March 10, 1874, arriving April 14. He then passed over the Central Pacific Railroad, of which he observes:

"In the construction of this railroad there are, as might be expected, many marks of great haste observable; and very inferior and perishable materials have in numerous instances been used. It would be a great mistake, however, to suppose that American Engineers of good professional position defend such construction on any other ground than that of necessity. The grand object both on this and the Union Pacific Railroad was to get the track laid as quickly as possible; and, in the case of such enormous distances as these lines cover, it was necessary, in order to do this, to make use of any material which was at hand." "I rode on an engine for some hours when crossing the Sierra Nevada; there were three engines attached to the train; the road was rough, and the speed at times on falling gradients very great, but the drivers appeared to have perfect confidence in their engines that they would not leave the road. I had opportunities of speaking to several drivers, Englishmen, who had driven in England; they all preferred the American to the English engine, which they said could not keep on such roads as are commonly to be found in the Western States."

Similar testimony was given later, from the experience of the Grand Trunk Railway, with both kinds of engine.

He then examined the Denver and Rio Grande lines, 3 feet gauge, at that time open for 120 miles. The maximum grade is 75 ft. per mile; it has one short curve of 478 feet radius, but generally the curves are not unfavorable. The rails are 30 lbs. to the yard, sleepers 6 ft. 6 in. long, 8x8 in section and spaced about 2 ft. 6 in. between centers; cuts 12 ft. 6 in. wide, embankments just wide enough to carry the sleepers, no ballast, no fences, bridges and culverts of timber; original cost $14 000 per mile, but much additional money was being expended on it; all surplus from earnings going towards improving the lines. The rails are too tight and are wearing out fast. The rolling stock is proportioned as follows:

Passenger engines, cylinders, 9"x16"; drivers, two pairs coupled, 36" to 40"; wheels of truck, 24"; total wheel base, 11' 11"; rigid base, 6' 3". Weight, 25,000 lbs., on drivers, 20,000 lbs. Freight engines, cylinders, 11"x17"; drivers, three pairs coupled, 36". Weight 35,000 lbs., on drivers 31,000 lbs. Passenger cars, 40 ft.x 7' 9" outside. Weight 12,000 lbs., to carry 33 passengers. Freight cars, box, 24 ft. long, weight 8 000 lbs., to carry stores; coal cars 24 ft., weight 7,500 lbs., to carry 8 to 9 tons; flat cars, 24 ft., weight, 6,000 lbs., to carry 8 to 9 tons.

It is admitted that the line could be worked with much greater economy, if more powerful engines could be used on it; but this would be impossible without heavier rails.

The Colorado Central, Kansas Pacific, and Missouri Pacific were passed over; but he made no special comments. The Chicago, Burlington & Quincy R. R. permanent way is spoken of as a marked improvement on the lines in the West over which he travelled. He quotes at considerable length from a report of the joint Commission of Railroad and Harbor Commissioners, made at Boston in 1871, on "Terminal Accommodation for Passengers," in which they proposed that four separate passenger stations, each 700 ft. long by 125 ft. wide, with streets between and adjoining them not less than 60 ft. each in width, should be provided for the passenger traffic which centers in Boston, the population of which, in 1874, was about 325,000. The daily passengers were about 58,000.

He travelled from Chicago to New York by the Michigan Central, Great Western and Erie Railroads. He remarks on the pattern of rail; the use of spikes in place of screw bolts to fasten the rail to the sleeper; the direct support of the fished joint, in place of its being suspended between two sleepers; the iron bridges, the station buildings, etc. "The permanent way of the best of the railroads of the Eastern States is not, in my opinion, equal to that of the best lines in England; the road bed is not so good, nor the drainage so complete, and dog spikes do not make so good a fastening as screw bolts." But he remarks that screw bolts cannot be used wh re a road bed is frozen hard in winter. He next went over the New York Central & Hudson River R. R., the Ottawa & Prescott and the Grand Trunk railways. He inspected the Toronto and Nipissing. 88 miles, and the Toronto, Gray & Bruce, 190 miles, both railroads of 3 ft, 6 in. gauge, and often quoted in narrow gauge discussions, What he states in reference to these lines will probably be of interest. As they are alike he describes only the former:

"It is a well constructed line of its kind, has a good road bed of gravel ballast, and iron rails, Vignole's pattern, weighing 40 lbs. to the yard, laid on transverse sleepers. There are no works of any importance, the line being kept on the surface of the country. The ruling gradient is 105 feet per mile, and the greatest length of this gradient is 4,650 feet. There is one short curve of 400 ft. radius, but the ruling curve is 600 ft. radius; even this is complained of as causing serious additional expense in working the line, more especially when it occurs on a steep gradient. The station buildings are very small and incomplete. Engine drivers are ordered not to run over any mile of the line with a passenger train at a higher speed than twenty miles an hour, or with a freight train than twelve miles an hour. This railroad has cost $18,000 per mile, including land, stations, rolling-stock and engineering. Grain, lumber and firewood are the principal items of freight, and in the year endfng June 30, 1873, 82,000 passengers had been carried. In the same year the gross receipts had amounted to between £8 and £9 per mile per week, and the working expenses were about 56 per cent. of the gross receipts. The traffic was improving. It was admitted to me by all those connected with the management and working of the narrow gauge railroads in Canada that a false economy was adopted in constructing them, and this admission was made by gentlemen who had been the most earnest advocates for a gauge of 3 ft. 6 inches, for steep gradients and numerous and sharp curves wherever expense could be saved by using them, and also for light rails, engines and rolling-stock. The experience of a year and a half's work of the line had completely changed their opinions. The 40 lbs. iron rails, with which the lines were laid, were wearing out, and steel rails of 56 lbs. to the yard were used to replace them; the light engines could not haul profitable loads, and the sharp curves greatly reduced their efficiency. I was told that it would have paid well to have spent more money on earthworks, and by so doing avoided the sharp curves and shortened the line; and that it was bad economy to use any curve of less radius than 1.000 feet, even with a gauge of 3 ft. 6 inches. As to this gauge there was also a complete change of opinion. The saving which had been effected by using it had not been found to compensate for the evils of the break of gauge with the Grand Trunk railway of Canada. I was assured there was every probability that both lines would be altered to the gauge of the Grand Trunk, which is now 4 ft. 8½ inches; and the Victoria R. R., a new line in connection with the Toronto & Nipissing line, the works of which had just been commenced at the time I was at Toronto, was to be made of this gauge. It appeared to be a settled opinion in Canada that no more railroads of the 3 ft. 6 inches gauge would be made there; not because lines on this gauge could not, with suitable rails and engines, carry the traffic of the districts through which they pass, but because the expense and other evils of a break of gauge more than outweighed any economy which could be effected by using the narrow gauge."

The English rolling-stock had proved a complete failure and has been replaced by American engines and cars. One Fairlie engine on the Nipissing road was well spoken of, as also this class of engine on the Denver & Rio Grande road: "with these two exceptions, the opinions which I heard from those who had experience of the Fairlie engine were most unfavorable." The passenger engines were, weight 33,600 lbs., cylinders 11" 18", 4 driving wheels, 39" diameter. Freight engines 56,000 lbs., cylinders 14x20, 6 drivers, 39" diameter. Passenger cars, 40 ft.x8' 8", outside, to carry 40 passengers. and weighing 26,400 lbs. Box cars, 28'x8', weight, 14,500 lbs., to carry 10 tons.

Of the break of gauge between the Grand Trunk and the U. S. railroads, he says:

"All the numerous plans far transferring freight from the cars of one gauge to those of the other had been tried, and also instructions for lifting the bodies of the cars off the bogie trucks and transferring them with their freight; but these various schemes were found to be mitigations only of a great evil, and, as I have already said, it was determined to alter the gauge from 3 ft. 6 in. to 4 ft. 8½ in."

The new steel rails of the Grand Trunk weigh 65 lbs. per yard. Cast-iron wheels are not liked on that road.

Mr. Higinbotham inspected the Mt. Washington railroad, the steepest in the world, and the pioneer of mountain lines; length of line 3 miles, average rate of ascent 1 in 4, steepest gradient 1,980 ft. in a mile, or 13½ inches in 3 feet., line worked by rack on track and pinion on engine, time of ascent 1½ hours. He then passed over the Boston, Concord & Montreal railroad, and from Boston to New York by the way of Springfield. "On some lines the rolling-stock is heavier than on others, and for several years there has been a constant tendency to increase the weight of the stock. This tendency seems now to have reached its limits, and there appears to be a stong feeling on the part of railway companies that the dead weight carried is excessive." He draws a general conclusion, from weights on various roads, that an ordinary passenger car in the United States weighs 630 lbs. for every passenger which it can seat; that a box freight car, covered, when fully loaded, carries 1 1-7 times its own weight; and that a flat or platform car carries 1 2-5 times its own weight. He praises the railroad stations of the Eastern States; the yard room is considered ample, the "Train Dispatcher" is spoken of, etc.

What he thinks of our bridges is noticeable, as coming from an English engineer:

"The iron bridges in the United States are among the most remarkable of its engineering works, and they differ in many respects from English bridges. In the former much greater care is taken in the selection of the iron than in the latter, and they are therefore lighter; pin connections are used invariably instead of rivets for all main parts, and all the fittings are engine-turned and planed. A greater depth of girder in proportion to the span is used in the States than in England; a depth of one-ninth to one-twelfth of the span is common in England, and one-fifth in the States. The bridge work is completely fitted before leaving the shops where it is made, and can therefore be erected with great rapidity and with unskilled labor; and being divided into a number of parts, is easily and economically transported. The differences in the two systems have arisen, no doubt, to a very great extent from the different conditions under which bridges are built in the two countries. In the United States very much larger spans are required as a rule than in England; the quality of the iron is superior to that in England, and economy in transport when distances are so vast, is of great importance. There can be no doubt that American engineers adapt their bridge designs to the conditions with which they have to deal with admirable skill; but it is questionable if these designs would be suitable either in England or here, where the conditions under which bridges are built are so different from those in the States."

Mr. Higinbotham spent five months in the United States and devotes 30 pages out of 72 to this country

He next sailed for England where he arrived in September, 1874, went to Glasgow and thence to Ireland. He states that in Ireland the bridge rail on transverse sleepers is condemned and going out of use on account of the difficulty of getting good joints with it, and that steel rails of from 73 lbs. to 80 lbs. per yard are going down in its place. The traffic on the Irish railways is small. The Great Western Railway and lines in connection with it, in the southwest of England and in South Wales were originally laid to the gauge of 7 feet. Most of the line has now been altered to 4 ft. 8½ in. The standard rail of the Great Western Railway is double-headed and reversible; it weighs 80 lbs. per yard, and is laid in chairs weighing 35 lbs. each, fastened by two ¾ inch bolts, passing through a cast-iron washer, and secured by a wrought-iron nut. The sleepers for the 4 ft. 8½ in. gauge are of Baltic timber, creosoted, and measure 9 ft. by 10 in. by 5 in. The intermediate sleepers are 3 ft. from center to center, and at the joints 2 ft. Express trains on the 7 ft. gauge are run at an average speed of 35 to 40 miles per hour by engines with a single pair of 8 ft. drivers. The narrow-gauge express engines have 7 ft. drivers. The engines have inside cylinders, wrought-iron crank axles, copper fireboxes, wrought-iron tubes, boiler plates ⅝" thick, pressure 130 lbs. per sq. inch. A disc wheel, with steel tire, cast-iron boss and remainder of teak wood, is coming into general use on this line.

The Westinghouse brake and the Smith vacuum brake are next discussed. Then follows a few facts in regard to the Metropolitan Underground railway in London, At the locomotive shops of the London and Northern

railway Bessemer steel is largely used for frames, boilers, fire-boxes, crank-axles and wheel ties. In coming to England from the States one is struck with the want of uniformity in the class of locomotive which is employed to do a particular work. One road runs an express locomotive with a single pair of drivers 8 ft. 1 in. diameter, while a lighter line uses express engines with two pairs of coupled drivers 6 ft. 6 in. diameter, and many engines on fast trains have only 5 ft. 6 in. drivers. American engineers condemn large driving-wheels, because they cannot be properly balanced, and experience has proved that the highest speed which is practicable can be obtained with wheels of moderate size. Inside cylinders are the rule in England. There has been a marked improvement in English rolling stock; the carriages are loftier and generally more roomy and comfortable than they used to be, and the wagons are built to carry greater loads. The statistics of passenger traffic in the United Kingdom for five years, ending with 1874, shows that in every 1,000 passengers, 90 travel by the first-class, 183 by the second-class, and 727 by the third-class carriages. Applying these figures to the average weight of each class of carriage, the result shows that the average dead weight per seat in the railway carriages in the United Kingdom is not quite 450 lbs. The block system with the interlocking of points and signals is very highly spoken of.

Mr. Higinbothom next goes to France, notices two-storied railway carriages on a line around Paris, and comments on the construction of other carriages and wagons. The coupling of the carriages are similar to those in England, but goods wagons are all furnished with screw couplings; and safety chairs, which have been discarded in England, are in use in France. French engines have a very heavy and clumsy appearance compared with those of either England or America. In many of them the eccentrics are outside the wheels; but this practice is being abandoned. Some of the passenger carriages are on six wheels and some on four; four-wheeled carriages form the great majority. There are about 19,000 kilometres (11,875 miles) of railway in France. Of these about 5,000 kilometres return a profit, some of them very large; but, of the remaining line, some do not ever pay working expenses.

He next passes over the Paris, Lyons and Mediterranean Railway from Paris to Nice, and then to Venice, visiting the Mont Cenis tunnel on the way. In construction the railways in the north of Italy follow the French railways, but the quality of the work is not so good, the lines are not well maintained, and the condition of the rolling stock is also very inferior to that on the great French lines. From Venice he went to Trieste and thence by railway over the Semmering Alp to Vienna. The tunnels and lofty viaducts at this pass are of much note. The carriages on the Austrian railways had wrought-iron sides, with very strong wood framing. Sheet iron is used for panels. Steel fire-boxes and boilers have been tried on the State railways, but the experiment on the whole was not successful, though at first promising. Corrugated copper fire-boxes are now being tried. The inferior quality of the fuel in Austria is a serious difficulty to engineers. One pound of the best Austrian coal will not evaporate more than 6 pounds of water, and the same weight of inferior coal will not evaporate more than 3 pounds. This makes very large fire-boxes and long boilers necessary. The engine drivers all work on premiums for economy in the consumption of fuel.

The rolling stock in North Germany, speaking generally, is of very strong construction, and the useful load bears a good proportion to the gross load. The more recent vehicles have frames of wrought-iron, and steel disc wheels are very generally used.

The narrow gauge railways of Norway, constructed by Mr. Carl Phil, were visited. At that time, 194 miles of railway, on the 3 ft. 6 in. gauge were in operation, about the same length was in course of construction, and 170 miles were projected. The cost per mile varied from £2600 to £6900. These lines, having almost exclusive possession, are not troubled by break of gauge.

"The Norwegian narrow gauge railways are well-constructed lines of their class, and appear to be sufficient for the light traffic of the country. The ordinary formation width is about 13 feet. The ballast is good and sufficient in quantity. The lines are fenced throughout, and there are gates at all road crossings. The culverts are built of stone; the bridges of large span are of stone and iron, but the small spans are of wood, and these constitute the great majority."

"The rails are laid on transverse half-round sleepers 6′ 6″ long, by 9″ by 4½″; the Vignoles pattern of rail is used; the 40 lbs. rail has a base of 3¼″ and a depth of 3 and 9-16ths″; the joints are fished, and are suspended between two sleepers."

The sleepers are spaced 2′ 9″ at middle of rails, changing gradually to 18″ at the joints. The rails are fastened by 5″ spikes, two to a sleeper.

There is very little of general interest in regard to railways in other countries in Europe. The average fares for passengers by first, second and third-class carriages on continental railways is put at about 1.8 *d.*, 1.2 *d.*, and 0.6 *d.* respectively per English mile.

He went to Bombay in October, and, as the Indian railways were constructed by English engineers, he did not expect to meet with any novelties. The introduction of the gauge of one metre in some parts of India had brought about some of the troubles experienced elsewhere.

"The adoption of so wide a gauge as 5 ft. 6 inches for the lines of railway which were first made in India was certainly unfortunate. If the 4 ft. 8½ in. gauge had been used, the metre gauge would probably never have been introduced. The earlier lines, having been made under the extravagant system of a guarantee by the Government of five per cent. on the amount which the companies expended, were, as might have been expected, very costly. This high cost was attributed to the gauge, hence the introduction of the narrow gauge. The great Indian Peninsula Railway passes over the mountains by the employment of changing stations and zig-zags. Iron pot sleepers are largely used, both with broken stone ballast and sand and gravel. The road laid on these sleepers does not run so smoothly as on wood. The first cost is greater than for wood, but they are more economical in the end, as the latter are destroyed by white ants; these do not work in the sleepers in the road, as the passage of trains disturbs them, but they quickly destroy sleepers which are in stacks. The wooden keys for fastening the rails to the chairs were destroyed in the same way, so that steel keys are now employed. The heaviest gradient in crossing the Ghauts is 1 in 37 and 1 in 40 is common. The engines on these inclines are of the tank class with four pairs of coupled wheels, 4 ft. diameter; they weigh 50 tons in running order. Catch sidings are employed, having a gradient of 1 in 10 opposed to the gradient of the main line, to check any train which may run away. All trains descending have to pull up at the points of each catch siding. The greatest works on Indian railways are the bridges over rivers. They are almost all iron girder bridges of large spans. Many of the rivers are subject to violent floods, and scarcely a year passes in which they do not produce disastrous effects on the railway works. The bridge piers are, many of them, stone or brick. Some difficult foundations were made by means of brick wells; in the Chenaub bridge these have been carried to a depth of 60 feet below the bed of the river.

CHIEF JUSTICE CURTIS, of the Supreme Court, New York city, has decided in favor of the right of the N. Y. Elevated R. R. Co. to construct their road across the Battery.

A GENERAL (Quarterly) meeting of the *American Institute of Mining Engineers* will be held in New York, beginning Tuesday, Feb. 27th, at 8 P. M., at No. 4 East 23d street.

A BILL has been introduced in the New York Legislature, now in session at Albany, for the appointment of a "Sanitary Inspector of Schools," whose duty it shall be to protect the children attending the public schools from the evils arising from bad sewerage and insufficient ventilation.

AT the meeting of the Franklin Institute, Jan. 17th the following officers were elected: —

President, Robert E. Rogers, M. D.; Vice President, Henry G. Morris; Secretary, J. B. Knight; Treasurer, Fred. Fraley. Managers to serve three years,—Prof. E. J. Houston, Enoch Lewis, C. H. Banes, Wm. Helme, Sam'l Sartain, Chas. Bullock, John Sartain, C. Chabot. Auditor, Wm. Biddle. Representative to the Pennsylvania Museum and School of Industrial Art, J. B. Knight.

AT the last meeting of the Civil Engineers' Club of the Northwest, Mr. W. B. Rice exhibited an improved style of pontoon bridge, the model of which was examined with a great deal of interest and attention by the members of the Club. The patentee was called upon by Messrs. Hjortsberg, Chesbrough, Morehouse, Smith, Greeley, Thomes, and others, to explain in detail the various parts and workings, and favorable opinions were expressed. The principal feature of Mr. Rice's improvement consists in overcoming the varying grades of the approaches by keeping the track level automatically at all stages of the water. We hope to be able to give a more extended notice of this important improvement in bridge construction at an early date.

THE following are elections and changes and corrections of members of the American Society of Civil Engineers for January:

Additions.—James G. Batterson, [F.] Hartford, Conn., June 7, 1876; George H. Mendell, Maj. of Engs., U. S. A., Sept. 6, 1876. *Changes and Corrections.*—Arthur Beckwith, Room 54, Coal and Iron Exchange, Cortlandt and Church streets, New York; Leonard F. Beckwith, President Fire Proof Building Co. of New York, Room 54, Coal and Iron Exchange, Cortlandt and Church streets, New York; Charles E. Billin, Box 2580, Philadelphia, Pa.; L. G. F. Bouscaren, Cons. Eng. Cincinnati Southern R. R., Cincinnati, O.; Thos. B. Brooks, Monroe, N. Y.; Elmer L. Corthell, South Pass Jetty Co., 122 Common street, New Orleans, La.; Charles G. Darrach, 3906 Woodlawn street, W. Philadelphia, Pa.; Edwin A. Doane, Myrth Block, East Fifth and Utica streets, Oswego, N. Y.; Arthur L. Ford, 80 West Sixth street, Oswego, N. Y.; James C. Kennedy, Care William Kennedy & Sons, Owen Sound, Ontario, Canada; Peter A. Peterson, Chief Engineer Q. M. O. & O. R. R., Montreal, Canada; Andrew J. Post, 136 Magnolia avenue, Jersey City Heights, N. J.; Thomas S. Sedgwick, 732 Twenty-first street, N. W. Washington, D. C.; Robert P. Staats, 349 West Fourteenth street, New York.

FROM the recent report of the test of the West Side Pumping Works, in this city, we gather that the two engines, coupled, pumped during the whole test at a rate somewhat in excess of thirty millions gallons in twenty-four hours; that they delivered the water under a head equivalent to elevating it over 155 feet above the surface of the water in the pump well; but that the engines did not develop a duty of 90 millions pounds of water lifted one foot for each 100 lbs. of coal consumed. In the first two points the engines fulfilled the contract but in the last one they failed. The commissioners are of the opinion, however, that under more favorable circumstances of operation and weather, and with more skillful firing, a higher duty can be obtained. The experts who conducted the test were Moses Lane, Chas. H. Haswell, Chas. Hermany, Thos. J. Whitman, and Henry Warrington.

The question then arises whether the city shall take the engines. As they have failed to satisfy the requirements of the contract in the duty test, the contractors may be required to make that specification good, for which they have some nine months' time, or to take the pumps away. In the latter case the city will be unable to supply their place for a considerable time, and the West Side works are needed forthwith, not only to fully supply that portion of the city, but to relieve the present works on the Lake Shore from the constant strong draught on their energies.

THE advocates of underground railways in the city of New York are pushing forward with renewed vigor, and it begins to look as if something would soon be done. That the work has not been inaugurated before, and even carried nearly through to completion, was due to the number of schemes which were urged at the same time. Very little of the talk and few of the applications for charters from the Legislature were sincere. There was much speculation mixed up in the matter, a desire to head off rival projects, and a strong opposition started and encouraged by the proprietors of present modes of conveyance. Then property owners were sensitive, and afraid of damage to their estates. The Gilbert Elevated Railway is the only one which has pushed ahead in spite of hard times and litigation, so that now it is acknowledged by disinterested persons to be a safe, comfortable, quick and altogether satisfactory line of communication between the two ends of its route. More improvements, additional rolling stock and an extension of the line are now assured.

Besides this line there have been advocated, an ele-

vated line running over the middle of an avenue; an underground one in a subway in the same location; an elevated road through the middle of the blocks; and an underground line in a single tunnel. The subway was to extend from curb to curb, or house to house, and give an underground, a two-storied street, one for rapid transit and freighting business, the other for ordinary business and pleasure uses.

SINCE the New York & Harlem Railroad has completed its new sunken tracks from the extreme northern boundary of the city, through Fourth avenue to Thirty-second street, a distance of about twelve miles, it is now urged that the construction of an underground road of about two and one-half miles, from the Grand Central depot to the City Hall, would put the upper and lower parts of the city in communication with one another by steam. Such a line seems entirely feasible, and it could be built in a very short time. The New York & Harlem road, paying prices for material and labor that ruled at the time of letting their contracts in 1872, constructed a roadway for four tracks, through more than half the length and the rockiest part of the city, for some $1,500,000 per mile. The two central tracks are divided from the other ones by heavy walls, and the middle portion is generally uncovered, while the side tracks are covered by iron beams and girders with brick arches, the whole forming the roadway for Fourth avenue. Considering the cost of this mode of building, the width required for the road from the depot to the City Hall, the fact that a simple tunnel would be excavated, and that there would not be so much rock cutting, the estimated cost for the extension is put at $1,000,000 per mile. Mr. Wilson, of the firm of Fowler & Wilson, engineers of the London Underground railway, has carefully examined the ground, and has placed the cost, excluding stations, and at present prices, at less than the above sum. It is desired to raise $1.000,000 among capitalists in New York, and to get the balance from other sources. If the enterprise is properly administered, there is no doubt but what it will pay handsomely.

THE most prominent man now before the public in connection with the proposed Detroit Tunnel is Wm. Sooy Smith, C. E., who offers to provide the money and build the tunnel if he is guaranteed the interest on the money expended, and when the success of the scheme is demonstrated he is to receive his pay.

Mr. Jas. F. Joy, the well-known railway magnate, having denounced the proposition of Mr. Smith as the scheme of a visionary enthusiast, without taking the trouble to examine into the merits of the proposed plan, we have been led to make some inquiries as to the record of the engineer whose reputation is thus rudely assailed, and we have learned the following facts:

W. Sooy Smith graduated from the Ohio University in 1849, and from West Point Military Academy in 1853, taking the degree of M. A. from the Ohio University in 1860. In 1854 he commenced his practice in civil engineering as Chief Asst. to Col. J. D. Graham, U. S. Eng. in charge of the harbor improvements on the Upper lakes. He was engaged in the surveys for the location of the International bridge at Buffalo, and in surveys for a ship canal around Niagara Falls on the American side. He removed the submerged rocks from Buffalo Harbor by blasting without drilling. He was subsequently Chief Engineer for a New Jersey Iron Bridge Building Co. by whom he was sent to the West Indies in charge of some bridges to be erected there. At the time the war broke out he was engaged in putting in pneumatic cylinders for the piers of a bridge over the Savannah river; but entering the army he served until near the close of the war when he was obliged to retire on account of ill health. After the close of the war he was employed by the U. S. Lighthouse Board on the repairs of the Waugashanse Lighthouse, which stands on a rocky shoal 2½ miles from shore. While engaged on this work he designed and sunk the first pneumatic caisson put down in this or any other country, with which he surrounded the lighthouse tower and carried to satisfactory completion the work on which he was engaged.

As Chief Engineer of the bridge-building firm of L. B. Boomer & Co., now the well-known American Bridge Co., he superintended the construction of the first pneumatic cylinders sunk west of the Alleghanies, at Omaha and Leavenworth, for the bridges over the Missouri river at these points. He was also the first engineer to introduce the use of the screw pile in the west, which he did in sinking the piers of two bridges in Nebraska, following it with putting in screw pile foundations for the piers of a bridge over the Mobile river, 14 miles from the city of Mobile.

From first to last he was the engineer of the great railway bridge over the Missouri river at Booneville. Besides these important works he has from time to time been engaged on various public works of more or less importance. He has also served on several important engineering commissions, and he originated the effort to induce the U. S. government to appoint a commission to establish and carry out a series of tests of iron and steel, of which commission he is a member.

He was the chairman of the Centennial Commission of the American Society of Civil Engineers on Foundations and Masonry, and was one of the experts appointed by the government to examine the foundations of the Chicago Custom House, and is now one of the board to devise means for the drainage of South Chicago.

In view of the fact that he has had a very extensive experience in under-water engineering and in the development of the pneumatic system, assisting in the preparation of plans for some of the most difficult under-water works in the United States, such as tunnels, caissons, pier foundations, etc., it is but fair to presume that he knows whereof he speaks when he makes his proposition respecting the Detroit Tunnel, and if his scheme is a visionary one, it must have a pretty fair showing for success to induce the capitalists who are backing the engineer to squander their money in the project.

Personally, Mr. Smith is a most matter of fact individual, and if the quite ample fortune which he has amassed from his profession is a sign of his "visionary" prochivities' a few of his brother engineers will pray to to be blessed with the same failing, Mr. Joy notwithstanding.

PROPOSED SCIENTIFIC EXPEDITION AROUND THE WORLD.

The object of the Expedition is to visit points of general and special interest; to obtain knowledge of the manners and customs of different races, and to study Architecture, Archæology, Geology, and the Fauna and the Flora of new or little known localities, and to make collections and studies in natural history generally.

To attain this end the Expedition will visit not only those localities of known interest, but also places nearly or entirely unknown to the naturalist.

For the purposes of this Expedition there will be a thoroughly first-class steamship of a thousand tons burden, fitted with state rooms, and saloons for study, work, lectures etc., and provided with steam launches, a large number of boats and a sufficient armament, and commanded by experienced officers, with a trained crew.

There will be provided a large library and a full supply of scientific apparatus for research, and material for the preservation of specimens.

The Scientific Corps will consist of a Faculty of ten, now being organized from among the professors of the leading Universities.

Instruction will be imparted by lectures on all subjects that can be studied with particular advantage on an expedition of this kind.

Preliminary work and training will commence as soon as practicable after the vessel leaves New York.

There will be accommodations for sixty to eighty students.

As the vessel will carry no cargo other than its outfit, there will be ample room for commodious accommodations, as well as for the storage of extensive collections in natural history and curiosities.

Every facility will be afforded for study and research, and special attention will be given to the convenience, comfort, and health of all on board.

As a good table contributes materially to the health and enjoyment of such an expedition, every care will be taken to secure good cooks and stewards, and the best provisions circumstances will allow. To this end the Expedition will take every opportunity to recruit, refit, and obtain fruits and fresh provisions; this, with the great improvement in canning fruits and meats, will secure the best of diet. Ice will be manufactured on board the vessel.

It is intended that the table shall be as good as that furnished first-class passengers on the best transatlantic steamships.

The Faculty will consist of specialists in the following subjects: Modern Languages, History, Architecture Archæology, Ethnology, Astronomy, Navigation, Geography, Botany Zoology, Geology, Paleontology, Physiology, Comparative Anatomy and Taxidermy.

There will also be an experienced physician and surgeon and a chaplain; also a photographer, with proper apparatus for photographing all objects of interest; thus retaining a complete panorama of the voyage for future reference and publication.

It is expected that large and extensive collections in Natural History will be made. These collections will be one-half the property of the students and faculty, to be disposed of as they may determine, and one-half the property of the ship.

The route proposed, subject, however, to such variations as experience may show to be advantageous, is as follows: Leaving New York in July, 1877; touching at the Bahamas, Tortugas and Havana; thence to the Island of Marajo, at the mouth of the Amazon, where time will be given to explore the curious ancient remains consisting of decorated burial urns and other pottery (still almost entirely unstudied), and also for the making of collections in Botany and Zoology, for which the locality is so noted. A portion of the Expedition will ascend the Amazon.

Thence to the Straits of Magellan (touching at Rio and Montevideo, and the Falkland Islands), where some stay will be made to allow of excursions inland to study the natives and make collections; thence to Valparaiso to receive letters from home; from thence the Expedition will proceed westward, touching at several of the beautiful Polynesian Islands, famous for their delightful climate, fruits, corals and sea-shells, and monumental remains of former, forgotten races, and presenting favorable opportunities for dredging. Thence touching at Australia and at New Guinea to obtain some of the strange animals and birds of those countries.

Macassar will be visited for coal and to obtain guides for northeast Borneo, Macassar being the head-quarters of the Dutch trade with that part of the island. It is hoped by the aid of these Dutch traders (who have offered their assistance to a member of the Faculty who has just returned from a scientific tour of some years in this locality (to cross the northern part of Borneo from the east to the west side, visiting the great lake and high table-lands which are supposed to be there. There are strange stories of this great inland lake and of large animals, among them the elephant. All work done here will be new, not only in natural history but in geography and ethnology. Thence to the Sooloo group, which is almost unknown scientifically; the natives are at war with the Spanish, and are piratical, but are friendly with all speaking the English language.

The parts of the Phillippines visited will be mainly those unexplored and promising great novelties in natural history. The island Basilan will be visited from Lambauga, and trips are planned to cross the island of Mindanao in two directions, as nothing is known of its natural history or geography except in the immediate vicinity of Lambauga. No difficulty is apprehended, as villages of Christian Indians with Spanish priests are found along its coast, and these have friendly intercourse with the interior tribes. Thence to the islands of Samar and Leyte, which are scientifically unknown, although there is nothing to prevent a thorough examination, as the natives are friendly. Zebu is visited as a coaling port and for dredging, the neighborhood being rich in corals, glass sponges and shells.

Manilla is visited, as the capital of the Phillippine Islands. Within easy reach are found villages of that curious people, the Nigutos or Attas, supposed to be of Papuan origin. An excursion will also be made to the unexplored island of Mindoro. The north end of Luzon, with its rich mines of copper and gold, will be visited, as this part of the island has never been scientifically explored. Thence to Hong Kong and the great Chinese city of Canton, where sufficient time will be taken to visit points of interest. Thence to Takao, on the southwest of Formosa, which is the head-quarters of a Chinese trade in junks to the east coast. Pilots and interpreters will be procured here for that part of the island where it is known Chinese traders are living." The western portion of the island is entirely unexplored.

The peaks of the mountain range reach a height of some 12,000 feet, promising a new fauna and flora resembling that of temperate regions. An effort will be made to cross the island to the Chinese settlements on the west.

An excursion of this kind will be of great geographical interest.

Thence down the China Sea to Singapore, from whence excursions will be made to points of Archæological interest in Malacca, Sumatra and Java, and for the study of natural history. (Here, as well as at other points, students will accompany excursions most to their tastes).

Thence up the straits of Malacca to Calcutta; thence to Ceylon, the Laccadive Islands, and Bombay; making such other stops as may seem desirable, and giving those who wish to do so, the opportunity of leaving the vessel at Calcutta; making excursions through India for the purpose of studying her wonderful architectural remains; joining the Expedition at Bombay. Thence to Aden and the Suez Canal to Alexandria, from whence an excursion will be made ap the Nile. While in the Mediterranean points of most interest will be visited, including the Holy Land, Cyprus, Smyrna, Constantinople, Athens, the ruins of Troy, Naples, Pompeii, Rome, Pisa, Florence, Venice, Verona, Milan, Genoa, Gibralter and Malaga; thence to Havre, France giving ample time for those who desire to make excursions through Spain and France to Paris, stopping at points of interest on the route. From Paris excursions can be made to Bouvais, Amiens, Arras. Brussels, Waterloo, Cologne, Coblentz, Strasburg, parts of Switzerland, Troyes, Rheims and Rouen, joining the vessel at Havre. Thence to London, visiting points of interest in England. Thence to New York, touching at the Azores.

The voyage will occupy two years, and as about two-thirds of this time will be in port, it is thought that sufficient stay can be made at all places visited to satisfy the objects of the expedition.

It is estimated that the distance travelled will be about 50,000 miles.

Any localities in which there may exist epidemics will be avoided.

The students will be drilled sufficiently in military tactics and boating for self-preservation, and when on shore in uncivilized localities, they will be under military discipline.

All travelers who have made long journeys to partially civilized countries, have found that the principal hardships are from want of cultivated society, music and good food, and of proper care in case of sickness; all these will here be avoided; several of the Faculty will be accompanied by their wives or daughters. The cabin will have a piano, and a brass and string band will be organized from among the ship's company; care will be taken in selecting waiters to obtain those of some musical ability.

The Expedition will fly the flag, and adopt the uniform of the Brooklyn Yacht Club.

Students desiring to accompany the expedition can obtain further information by applying to either James O. Woodruff, Indianapolis, Ind. Prof. W. L. B. Jenney, Portland Block, Chicago. Prof. J. B. Steere, University of Michigan, Ann Arbor, Mich.

REGULAR MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

[REPORTED FOR ENGINEERING NEWS.]

The American Society of Civil Engineers held their regular meeting for February at their rooms, No. 4 East Twenty-third street, New York, on the evening of the 7th inst. The first business in order was balloting for new members, and the following were elected:

Members.—Frederick S. Benson, Engineer and Superintendent of Nassau Gas Light Co., Brooklyn, N. Y; Eckley B. Coxe, Mining Engineer, Drifton Pa; William C. Gunnell, Engineer of New Capitol, Hartford Conn; David E. McComb, Assistant Engineer in charge of Works west of Capitol, Washington, D. C.

Junior.—Sanford Horton, Civil Engineer, New York.

After the election of members a ballot was taken on the question of appointing a Committee to report to the Society a form of Memorial to Congress urging the adoption of the Metric System of weights and measures, resulting in a vote of 138 for and 93 against the proposition.

A lengthy paper was then read by Mr. Henry F. Walling, C. E., on Co-ordinate Surveying, in which, in summing up, he claimed the following advantages would arise from its adoption: First. The attainment of the highest practicable degree of accuracy as well in smaller local surveys as in more extensive operations. The units of measurement used by the United States Coast Survey are found, after most careful comparison with those of other countries to have a degree of precision not yet excluded by scientific skill anywhere. Second. Extreme simplicity of notation with ease and convenience of field work and computation. Third. Facility in graphical representation. Fourth. Absolute certainity of location in description of conveyances and consequent removal of a fruitful source of litigation and trouble. No change is proposed in existing methods of determining the third ordinate, *i e.*, altitude. This third ordinate is the height of the point above the level of the sea.

The paper was referred to the Committee on Library with the recommendation that it be printed.

After the reading of this paper, some facts and opinions were discussed relating to the failure of the railroad bridge at Ashtabula, Ohio, during which two letters were read, one from Mr. G. K. Warren in which he contended that the sudden snapping of the bottom chords, or of a tie, would produce the same sensations to the occupants of the cars in the immediate vicinity, as if the car had jumped the track.

Another letter was read from Mr. E. S. Philbrick giving the results of observations made by his assistant Mr. A. H. Howland.

A close description is there given of the position of the wreck; after which he continues: All the 1 beams forming the top chords, the main braces and floor beams were dragged out as soon as possible after the disaster, and irrevocably mixed. But the position of the bottom chords, vertical rods, angle blocks, etc., taken together with the evidence of the enginemen seems to indicate that the failure began by the breaking or displacement either of main braces or top chords in the second or third panel from the west end of the south truss. The floor must have sunk first on the south side as that side only was loaded and the general position of the parts of the wreck confirms this hypothesis. Diligent search was made for evidences of derailment but none were found. Some forty railroad ties were found but no wheelmarks on them. A few wheels were broken or cracked but nothing to show whether they were sound or unsound before the fall. There seems to have been sufficient elements of instability in disjointed and poorly connected top chords and main braces to account for the disaster.

Notice was also read of the next meeting of the American Institute of Mining Engineers, to be held on Tuesday evening, Feb. 27th, at 8 o'clock, at the rooms of the American Society of Civil Engineers. After which the meeting adjourned.

DETAILS OF THE ASHTABULA BRIDGE BY EDW. S. PHILBRICK, C. E.

This was a *deck* bridge, with two iron Howe trusses, each having fourteen panels of eleven feet length. The height of truss was 19 ft. 9 in. from center to center of chords; width between centers of trusses, 17 ft. 2 in.; width of deck, 25½ ft.; length between back walls, 158 ft. The bottom chords consisted each of five lines of bars each 5 in. × 1⅜ in., flat side up and side by side, each line consisting of two bars, one over the other, except that the third line drops the bottom bar in 2½ panels at ends of trusses, and the second and fourth lines drop the bottom bar in 3½ panels at ends. Rectangular lugs were welded to top bars at panel points to fit into traverse grooves of the cast angle blocks. These bars are in lengths of three or four panels. Splices were made by hooks fitted to square lugs on ends of bars and clamped by ferules driven or shrunk on. These ferules clasp the hook, the spliced and the continuous bar all at once. The angle blocks at panel points were all cast-iron; bearing faces nearly plane but not planed. L-shaped lugs were originalty cast on these faces 1½ in. long and ½ in. projection, to hold the braces in place, as these were originally put in viz., with the top and bottom flanges of the I-beams of which all the braces were composed, being parallel with the plane of the truss. We are told by men who were employed in its erection, that when first put together some wedges were drawn on the false works, the braces being in the position above described, and the braces had been clamped at their intersections and these clamps parted, allowing the braces to buckle and truss to sag. A few more wedges were drawn and it settled more, the braces getting some inches out of line. Mr. Stone was sent for and had it jacked up and the rods screwed up. The nuts could not be turned much. It was let down again on the false works and the braced turned 90° on their own axes. Additional ones were put in at the end panels, making six instead of four, and the bridge then stood. The little L-shaped lugs on the angle blocks were mostly chipped off to allow the braces to be turned, also some corners of braces, leaving them with nothing but friction to hold them in place; for what little was left of the lugs did not fit the new position of the braces. Paint marks now show them to have moved some inches out of place when last painted. The braces were all 6 in. I beams, rolled iron, with a section of 6 to 9 square inches, the heavy ones being supposed to be at the ends of trusses. Beginning at each abutment each panel had the following number of braces leaning forward toward the other abutment, viz.: 6, 6 ?, 4, 4, 3, 3, 3, 2, 2, 2, 1, 1, 1, 0. The end panel having no counterbrace, its main braces were stayed at half length by a bolt and gas-pipe strut passing to the first bottom angle block. There was no vertical end posts at the abutments. The top chords had each two of their members extending over to the back wall, where bore on rollers at one end, making a beam 12½ ft. span, composed of two six-inch I-beams directly under one rail of the track and carrying about 86 per cent. of the loads passing over this track, for the other beam was 17 ft. 2 in. distant. *The several braces of each set were connected only by a yoke of two rods of ⅝ in. diameter at their intersections at the centre of their length with cast packing pieces between them!* The vertical ties were 8 in number at each angle block 2⅛ in. diameter at ends, and varying to 1½ in. at middle of truss. They had forged heads at top, and were upset at bottom, where nuts were applied. Their ends bore against iron washer straps, which extended across full width of chords and on the bottom chord somewhat more at the inner end for connections of the lateral brace struts. These struts were railroad bars confined by a stirrup passing over top of rail and down through holes in bottom flange to bolt to the strap described above. They were applied at alternate panel points 22 ft. apart. The bottom lateral bracing was in panels of 22 feet, composed of flat bars, 2½ in. × ½ in. Their ends were hooked into recesses formed for the purpose in the cast-iron angle blocks, but they had no adjustment for length. A most unique feature in this bottom horizontal system was this, that the tie braces met at the chords at points *intermediate* between those where the struts were applied and 11 feet distant, so that if they had ever been screwed up the chords would have been pulled into a zig-zag or a serpentine line, while in their actual condition all the lateral forces arising from the wind or from the passage of trains over the bridge, instead of being counteracted or controlled, must have been *assisted* by this arrangement to break up the alignment. The top chords were formed of five lines of 6 in. I-beams, side by side, two panels long and breaking joints. Their ends abutted against cast-iron lugs on the angle blocks, 6 in. high, 5 wide and 1¾ in. thick, these lugs being omitted where the bar was continous, three at one point, and two at the next. *These I-beams were connected to each other only by ⅝ in. bolts and cast spools, two in a panel!* Instead of closely fitted end bearings they were *shimmed* at the ends against the lugs of the angle blocks. It is said this was done to give the desired camber, the top chord being cut a little short for that purpose. These shims were held in place only by friction. The weight of these 6 in. I-beams varied, their webs being from ⅛ to 1 in. in thickness. The heavy ones were supposed to have been in the central part of the length; but, as in the case of the braces, they were so scattered and mixed by the clearing of the ground, immediately after the disaster, in erecting trestles for the tracks, that little clue was left to their original position.

No broken ones were found, but they were bent and twisted in all sorts of shapes, as were also the floor beams, and all were generally completely separated by the fall. The floor beams were also 6 in. I-beams, spaced three to a panel and about 25½ ft. long. They rested directly

on the top chords, which were thereby subjected to transverse strains, by the passage of every wheel on the tracks. At alternate panel points there was a lug riveted to the bottom of a floor beam, fitting against the inner edge of the top chord, thus acting as a strut for the lateral bracing. The latter was in panels of 22 feet, composed of 1¼ in. round iron, flattened at ends and formed with a hook fitting a recess in the angle block, and held down by the weight of the top chord bars. There was no adjustment of length. A stirrup passed over the floor beam acting as strut, and confined it to the chord. There was originally only one track on the bridge, but of late years two had been used, spaced 7.20 ft. apart in clear, so the outer rails came almost exactly over the centre of the trusses. Under these rails were two pieces of longitudinal timber, each 7 in. × 12 in., and under the inside rails three pieces of same size. Another stringer lay outside, at each edge of floor. Don't know about any in middle, between tracks. The ties covered the whole width of 25½ feet, spaced one inch apart and made of oak, 3 in. × 5 in. Besides guard timbers on edges of floor, there were guard rails inside the tracks, converging to centre of track near end of bridge. This floor was better than the average of bridge floors, and if the ties were sound, as we have every reason to suppose them to have been, they would have sustained a derailed car and perhaps an engine, at least anywhere but in the middle of the width of the bridge. There was a pair of transverse vertical braces every 22 feet, made of 1¼ in. round iron, adjusted by turnbuckles. They were flattened at ends with a hook fitting a recess in the angle blocks, but were *held in place only by a top bolt of ⅝ in. diameter screwed into the castings!—The Railroad Gazette.*

CORRESPONDENCE.

NEW HAVEN, CT., *Feb. 8th, 1877.*

"SKILL AND CONSCIENCE IN BRIDGE BUILDING."

EDITOR ENGINEERING NEWS:

SIR:—In the article on "The Ashtabula Calamity," by Clemens Herschel, C. E., of Boston, published in your journal Feb. 3d, the necessity of "skill and conscience in bridge building" is well brought out; and certainly the importance of having such structures designed by competent engineers, and the construction superintended by skillful and conscientious inspectors cannot be too strongly brought home to persons and corporations contracting for bridges. Mr. Herschel also takes occasion to speak very depreciatingly of the so-called "American" practice of bridge construction, as contrasted with the "European or riveted system."

Now we take no exception whatever to Mr. Herschel's anathemas upon the use of cast iron in the principal members of bridges; nor even for joint boxes, although in certain designs for minor parts, where there is no possibility of transverse stress, we believe the best quality is not so *very* objectionable; still, it is not necessary, and may well be dispensed with, especially in railroad bridges. Neither would we have him retract one word of his disapprobation of simply butt joints and screw end main ties. But we think he might have made a clearer distinction between such structures and the well designed pin joint bridge, which has been worked up by American engineers, and has given to the "American system" its well deserved popularity.

Wrought iron posts connected to the chords with well proportioned pins, no more deserve the name of "simple butt joints," than the riveted connection, and are no more liable to displacement.

Mr. Herschel thinks it behooves engineers and bridge builders to express their opinions clearly and unbiasedly upon this question of connections; and certainly the joints of a bridge are the points that deserve the most *careful attention.* He has expressed his preference, and it is unreservedly in favor of riveted connections.

For very short spans, the riveted plate girder, when well proportioned, has never been excelled for rigidity and stability; and for very light trusses of short span, riveted work has unquestioned advantages as regards rigidity. But for long spans, and heavy bridges, the tables are turned. In such cases, the properly proportioned pin joint bridge (wrought iron throughout) we believe is not excelled by the riveted structure, and in many respects has decided advantages.

(1.) In the riveted bridge, the chords are usually built up of plates and angles, the web members riveted to the side plates, and the increments of horizontal strain at each panel point allowed for by additions to the top and bottom plates. By this arrangement the material in the chords is not symmetrically disposed with reference to the axis of strain; and the result will be that some parts may be strained more per square inch than the unit strains, and other parts less. In the pin joint bridge, one of the best forms of top chord is built up of a thin top plate and heavy side channels; thus the great bulk of the material is put where it will do the most good, and symetrically disposed with reference to the axis. In the lower chord links this result is obtained almost perfectly.

(2.) The lower chord of the riveted plan is usually trough-shaped, and catches dirt and snow, and during the winter is often filled with ice, unless covered over; thus adding to the dead weight, and doing the iron no good. With the lower chord links of pin bridges, there is no trouble of this kind.

(3.) The axes of the different members of the riveted bridge which are expected to assemble at the panel point (perhaps I should say ought to) do not ordinarily do so in all the panels. Transverse strains are thus induced which do not enter into the calculations. In the pin joint plan the different members do necessarily *all* assemble exactly at the panel point, and the strains are delivered exactly as they were intended to go.

(4.) In very long heavy spans, where the dead weight is very great in comparison with the live load, the waste of material on account of rivet holes in the tension members of the riveted bridge is very great. The weight of this *worse than useless waste* devolves additional duty on the effective section remaining, and the consequent necessary increase of the net section involves another waste. In the well proportioned pin joint bridge there is no such waste; every pound is utilized; and this is one of the principal reasons why for long spans the "American" system has competed so successfully with the "European."

(5.) On the riveted bridge a large amount of work remains to be done after it has reached the ground, and ordinarily this cannot be done nearly as satisfactorily or economically as at the factory. It usually requires a more elaborate system of false works, a much longer time, and more skilled labor to erect. These are *frequently very important factors* in the question of bridgeing; and in the pin joint system they are reduced to a minimum.

(6.) In the riveted bridge a large element of uncertainty creeps in, in the shape of hand riveting on the false works; of which a great deal is necessary. The rivet is usually smaller than the hole it is expected to fill, and unless care and pains are taken, it is possible and even probable that the shank of the rivet will not be upset its full length; and care and painstaking are commodities that under the sharp competition in this country are not allowed to be wasted in the erection of bridges. If all the rivets do not perfectly fill the holes (and it is highly improbable that they all will, as such work is ordinarily done), then such will be useless; hence some of the rivets will be strained excessively, and others not at all, and this again will complicate the strains in the connected members.

These objections apply equally to pin joint bridges, when "field riveting" is necessary; but little is necessary, and that little confined principally to cover plates in compression members, which are of but little consequence, or at least not of such *vital importance* as the connection of web members. Nearly all the riveting in the pin joint system can be done by power at the factory; and power riveting belongs in another catalogue entirely. If Mr. Herschel will devise a simple, cheap, and powerful hydraulic or other machine to do this work in the field in the most awkward positions, he will have overcome one of the obstacles to the introduction of riveted bridges.

(7.) The slightest deflection of any part of the riveted bridge, due to a heavy, concentrated load, will cause a tendency to transverse strain in the web members, and these members will act with a powerful leverage tending to shear the rivets by twisting; under such circumstances the rivets on one side of the member would have to take all the strain the load would send through that piece, and possibly considerably more. The practical effect of this tendency, however slight, to rack the rivets first one way and then the other, would be to loosen them; and this effect is intensified by the slightly diminished diameter of the shank of the rivet by shrinkage in cooling. The members of the pin joint bridge being hinged on a single large bearing, these difficulties are avoided.

(8.) The absolutely accurate fitting together of the different parts, and a consequent uniformity of strain, is not so certain in the riveted bridge—we may say almost impossible, as rivet holes are usually punched; and drilling in place is too costly for competition in this country; and where the drift pin needs to be used to draw, initial and transverse strains are again developed that cannot be computed.

It is just here that the pin joint bridge affords us a beautiful illustration of a perfect harmony between theory and practice. Each set of members or bars in each panel are all clamped together and bored *at the same time,* in a double end borer; therefore if the iron is at the same temperature (as there is only one hole instead of several as in the riveted bars), they must absolutely match; and the pin is turned to fit the hole to 1-64th of an inch. The members must all assemble exactly at the panel points of the strain diagram; the strains will therefore all be axial, and the members strained uniformly throughout their section. The engineer here knows just what he is about. He knows he will have just the strains on his diagram, and no other; and that he need not (as in some other systems) throw in a little material here, and a little there, to allow for strains that are not computable, or for imperfect workmanship.

We are well aware that *some* of the above objections to riveted bridges are not of much practical account, still, they are theoretical considerations of more or less weight, which do not apply equally to the pin joint bridge. And where without sacrifice we can make practice harmonize with theory, why not?

We believe that for long spans, the "American" bridge, taken as a whole (we mean, of course, the best American practice), is *not* inferior to the "European or riveted" bridge, nor less *reliable,* as Mr. Herschel would lead us to infer. We claim for it economy, simplicity, equal if not greater strength with the same amount of material, and a combination of all those qualities that go to make up "an iron bridge of assured safety."

A.B. HILL, C. E.

NEW YORK, *Feb. 15th, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—Business continues to be very depressed and all engineering projects are affected. Still, the general feeling for the future is a hopeful one. At present very little practical work is being done and that is mostly on necessary city improvements, and the little work carried out on the East River bridge. The authorities of Brooklyn have decided to expend about $75,000 on storm sewers, giving those on contract which are to cost over $10,000. One of those proposed will cost about $10,000 and another about $25,000.

Quite a number of projected works in and around New York are talked of; among others an elevated road in the city, which is fighting for an existence in the courts. A road from Greenpoint, L. I., to Coney Island, undoubtedly for summer pleasure seekers, giving them access to the sea shore in half an hour. A second bridge between Long Island and New York is also occasionally talked of which, if built, would probably serve exclusively for railroad purposes and would be built entirely by private capital. The cities here have enough of building bridges for some time; their one attempt in that direction will satisfy them, for they find them to be expensive luxuries. The East River bridge was to have been finished in 1874, at an estimated cost of $7,000,000. After beginning the work $9,500,000 was asked for and in 1875 the estimates reached $13,000,000. The plans and estimates are not fully made yet, but, owing to the great depreciation of values in late years, the last named sum will probably cover the cost of the bridge. At present the interest on the amount expended is said to amount to about $1200 per diem, and yet the inhabitants of New York and Brooklyn have derived no benefit, thus far, from this enormous expense. It is hoped, though, that the future benefit to the two cities will amply repay them for the fearful tax now borne.

Mr. J. Lloyd Haigh, the successful competitor for the contract for furnishing the steel wire for the bridge cables, is making active preparations for its manufacture. In addition to his old works he is putting up a temporary structure 200 x 90 ft., in which the steel wire is to be galvanized. Owing to the incompleteness of the preparations very little has been done as yet in manufacturing the wire; last week ten tons were sent away. The contract requires the full supply of wire to begin on the first of April; it is expected that all arrangements for the manufacture will be completed before that time, and then about 150 tons of finished wire will be turned out weekly, giving employment to over 200 men. The wire made in these works, for the cable, is of superior quality. It is No. 8 wire, bearing on an average a load of 4,000 lbs. and stretching 4 per cent. before breakage. The contract requires that the wire should bear a load of 3,400 lbs. and stretch over 3½ per cent. before breaking. In a list of trials made, which I saw, the smallest breaking load was 3,540 lbs. which stretched the wire 4 per cent., and the greatest was 4,735 lbs., stretching the wire 4 per cent. A wire was tested in my presence which broke with a weight of 3,620 lbs., stretching it 4¼ per cent. All of the results agree very well with those of the tests made of Mr. Haigh's wire, at the competitive trial when his wire proved to be superior to any furnished by rival competitors. These results justify the wisdom of our bridge directors in awarding the contract as they did, especially as Mr. Haigh's price was below that of all rivals, viz: 8 and 7-10ths cents per lb. gold.

Experiments are still being made at Albany by our ambitious "statesmen" to legislate good government into New York city. The last thing reported is a bill about to be introduced, which proposes to reconstruct all the public departments in New York. By it the Dock Commission is to be abolished and all its powers and duties vested in the Department of Public Works. The Department of Buildings is to be merged in the Fire Department and the street cleaning is to be taken from the Police Department and put in charge of the Commissioner of Health. Like many of its predecessors this bill will doubtless be buried in some legislative pigeon hole, never to be resurrected, and all its good and bad points will soon be forgotten.

E. A. R.

COMPARISON OF IRON AND COMBINATION BRIDGES AS TO THEIR ECONOMIC MERITS.

EDITOR ENGINEERING NEWS:

SIR.—The testimony in regard to the Ashtabula disaster shows that while the tensile members of that structure were strong enough, those subject to compression were weak.

This fact proves nothing except that the bridge was not carefully designed, or more probably not constructed as designed; yet it is an exemplification of the tendency

BRIDGE AT PLAINFIELD, N. J. BY THE AUTHOR. 104 FEET SPAN; 25 FEET ROADWAY; 8 FEET SIDEWALKS; 100 POUNDS PER SQUARE FOOT; FACTOR OF 5 FOR SAFETY.

to push economy to dangerous extremes in proportioning the thrust members of a bridge. The temptation so to do is great in iron structures on account of the inordinate weight of their compressive as compared with the tensile members.

With a view of determining the facts as to the cost of using wood in compression in combination with iron in tension in bridges, estimates were obtained from a company engaged in building both styles of bridges as to the cost of each. Each to be of same span, strength, etc., and to contain same quality of iron. Also an estimate of cost of renewing the entire woodwork of the combination bridge on the supposition that the track must be kept in condition for the passage of trains during said renewal; below are the figures

For the Complete Iron Truss	$9,000.00
" " Combination	6,300.00
Difference in favor of latter	$2,700.00

To replace entire woodwork of Combination bridge, $1,800.00, including labor and provision against delay of trains.

These figures furnish the necessary data for comparing the two systems of construction. In making this comparison there must be considered, the interest on money invested, the cost of renewals, and a renewal fund sufficient to keep the truss in perpetual repair.

The interest on first cost is a factor in the problem because the total cost of a structure at any time is made up of the original expenditure added to the accrued interest. If built on borrowed money interest must of course be paid; if otherwise, the money could have been employed in some other investment which would have returned interest. This interest in the nature of things will be compounded annually.

The periodic renewals of the Combination will be provided for by a sum of money (in the manner of a sinking fund) which improved at compound interest will, during the intervals between renewals, amount to itself plus a sum sufficient to make the renewal. This in the following discussion will be called the renewal fund.

To express the relations of the quantities by formula which will be of general application, let

x = original cost of Iron Bridge, Vi total cost at any time.
c = " Combination, Vc " "
d = difference of cost $= x - c$
r = value of money in per cent. per annum.
p = cost of renewal.
t = number of years between renewals
a = renewal fund.

Any sum of money at compound interest in t years will amount to $p(1+r)^t$ Eq.(1)
in which p = the principal.

In consideration of the above reasoning the following formulated statements will be true

$Vi = x(1+r)^t$ Eq.(2) $Vc = c + a(1+r)^t$ Eq. (3)

Therefore at the time of construction for equal economy x must equal $c + a$.

Again at the time of renewal the total saving effected in the time t by the adoption of Combination in preference to Iron, must equal

$x(1+r)^t - c + a(1+r)^t$ Eq. (4)

Furthermore the renewal of the Combination can be made (and no greater expense incurred than the original construction of Iron would have involved) as often as the difference between the cost of Combination and Iron at compound interest becomes equal to itself plus the cost of removal, or whenever

$d(1+r)^t = d + p$ Eq. (5)

To apply these formulæ to case in hand the following assumptions will be made:

1st. That as regards painting and incidental repairs the two trusses will be on an equal footing.

2d. The Combination will require renewal every twenty years; this, considering that the timber is used solely in compression, and that the upper chords can be completely protected from weather action, is moderate and justified by experience, then will "t" = 20 years.

3d. That the rate of interest will be 7 per cent. Few railroads borrow money at so low a rate. Then will "r" = 0.07.

We do not yet know the value of "a" but it can be readily found from our formula. The amount which "a" must equal in twenty years is the cost of renewal plus itself (*i e*) $1,800 + a. Therefore from (1)

$1800 + a = a(1+r)^t$ whence $a = \frac{1800}{(1+r)^t - 1} = \$627.20$

"d" will equal $9,000 - 6,300 = $2,700.00

From 2 and 3 we find for equal economy the Iron truss should cost $6,300 + $627.20 = $6,927.20 instead of $9.000.

From (4) we have $9,000 × $1.07^{20} = $34,830.00$ for total cost of Iron.

From 4 we have $6927.20 × $1.07^{20} = \frac{\$26810.00}{\$8020.00}$ for total cost of combination. Showing a saving in twenty years of $8,020.00 by the adoption of Combination bridge.

From (5) we get, using logarithms for convenience of calculation.

$$t = \log.\frac{(d+p) - \log. d}{\log.(1+r)} = 7.55\text{-}100$$

That is to say every seven and one half years the Combination can be renewed without loss of money.

The formulæ by the aid of logarithms are very easy of application and afford a rapid method of comparing structures under like conditions.

The above comparison is made on the basis that the Iron bridge will last for all time. But there is a circumstance which must not be lost sight of, that is, that all bridges are liable to accident; the substructure may be undermined and destroyed. In extraordinary floods floating snags may carry them away. A derailed train may cut away the bracing and let the structure down, in short, innumerable contingencies may arise which would result in the destruction of a bridge. In any of these cases the loss on the Combination would be light, while that on the Iron truss would be heavy, amounting in most cases, to two-thirds the first cost. In one case of personal observation the cost of restoring an Iron bridge, so lost, exceeded the original outlay. This arises from the fact that the tensile members are usually merely bent, but can be straightened and used again, while the compression members of the Iron truss are so broken and deformed as to be well nigh worthless except as scrap iron.

With the above showing none need hesitate to build the combination truss from a monetary point of view. But to assert that Combination bridges should, therefore, always be built in preference to Iron would be absurd. In certain localities many considerations will determine in favor of Iron; still there are many situations in which the Combination bridge could with great advantage be adopted. V.

HIGHWAY BRIDGE AT PLAINFIELD, N. J.

The above illustration represents a bridge designed by Alfred P. Boller, A. M., C. E., the author of "BOLLER'S HIGHWAY BRIDGES," and used in his valuable work, a notice of which is given below.

BOOK NOTICE.

IRON HIGHWAY BRIDGES: — Practical treatise on the Construction of,—By Alfred P. Boller, A. M.

Iron bridges are becoming very numerous throughout the cities and counties of our Northern States. These structures are generally bought by parties who are not competent to judge as to what they are purchasing, and who seldom call in the services of an expert to decide for them and to see they obtain what they need. The bridges are sometimes sold by contractors who do not intend to supply a first-class article. The trusses which may be seen here and there, on any short journey, are sufficient witnesses of this fact to the trained eye. That they do not collapse is due to the generally light loads to which they are subjected.

Mr. Boller has pointed out in this book "the peculiarities of material and construction involved in the designing and building of Iron Highway Bridges, in the hope that a dissemination of their scientific principles in a popular form, will bear fruit in a more thorough appreciation of a noble art, and in elevating the standard of requirements of this very important class of public works;" and he has dedicated it "to town committees, selectmen, county freeholders, and other public officers, to whom is entrusted the responsibility of erecting Iron Bridges."

In the last enumerated class will come those surveyors and engineers who, not experts and not thoroughly acquainted with the details of this branch of engineering, are called upon, as county surveyors, or local engineers, to give their assistance and opinion in regard to a proposed bridge. To such persons, and indeed to everyone whose business does not lie exclusively in this line, we can heartily commend the book, for every section contains excellent instructions and advice. The second part is devoted to determining the strains in the ordinary forms of trusses in an elementary manner; it will be easily understood and very serviceable.

One piece of advice which the author gives has pleased us very much: "To ignore any plan of bridge that cannot accurately be analyzed as to the character and amount of strain occurring in all its parts." He gives some valuable information about eye-bars and pin connections and comments on riveted trusses. The only points to which we object are in relation to the bowstring girder. We do not agree to the statement that this type "is properly not a truss at all, but simply an arch wherein the horizontal tie takes the place of fixed abutments." Then we should have been glad to see the bowstring girder more treated fully, for it is a type of truss much used for highway bridges, and therefore one which the reader would especially desire to be informed about. Mr. Boller states that there are no strains on the diagonals of this truss when the bridge is uniformly loaded, and omits to mention that this is the fact only when the panel points of the bow lie in a parabola. Indeed, he says nothing about the curve; in the example worked out, the bow is neither parabolic nor circular.

PUBLICATIONS RECEIVED.

"*The History and Theoretical Laws of Centrifugal Pumps*, as supported by Experiment, and their Application to their Design." By the Hon. R. Clere Parsons, B. A., B. C. E., Dublin Stud. Inst. C. E.

"*The Chalk Water System.*" By Joseph Lucas.

Abstracts of Papers in Foreign Transactions and Periodicals.

"*Testing of Portland Cement.*" By Isaac John Mann.

"*The Fracture of Railway Tires.*" By Wm. Wirby Beaumont, Assoc. Inst. C. E.

Annual Report of the officers of the City of Allegheny, Pa., for the year ending December 31, 1876.

Journal of the American Society of Civil Engineers for January, 1877.

Annual Report of the Board of Trade of Minneapolis, Minn., for 1876.

NOTES.

The Louisville Bridge Co. has declared its usual six months' six per cent. dividend, payable Feb. 15.

In ten days another test of the West Side pumping engines will be made, under the direction of Messrs. Lane, Haswell and Warrington.

The Lehigh & Wilkesbarre Coal Company of Pennsylvania have applied for a receiver. It is thought the mines will be worked as usual.

The City Council of Fort Wayne, Ind., at their meeting on the evening of the 13th inst., passed a resolution postponing the special water works election, set for the 20th inst., until next May.

It is proposed to cut a broad canal from Manchester, in England, to the river Mersey. Manchester hopes to have a port of entry, accommodating vessels of 4,000 tons. A ship canal is also projected between the North Sea and the Baltic.

The Board of Trustees of Princeton College have elected three new professors:—Professor C. A. Young, of Dartmouth College, in astronomy; Professor Charles G. Rockwood, of Rutgers College, in mathematics; and Professor S. C. Oris, of Marietta College, Ohio, in Greek.

Sobrero considers two operations in the manufacture of dynamite exceedingly dangerous, namely, the mixing of the nitro-glycerine and the infusorial earth, and the pressing of the mass into moulds to form cartridges, as in either case an explosion may be produced by friction and pressure.

M. Mouchot is continuing his experiments in utilizing the heat of the sun. He has lately shown to the Paris Academy of Sciences a small still, in which the sun's heat was applied to the processes of distillation. With this still, the mirror of which was twenty inches in diameter, the inventor succeeded in distilling a quart of wine in half an hour.

Owing to the large number of emigrants from the old country forwarded by the Canadian emigration agents in Manitoba and the Northwest Territory being diverted from their route at Duluth by American agents, and induced to remain in the States, the legislature of Manitoba have petitioned the Dominion government to appoint an agent at Duluth for their protection.

Viehoff has described very favorable results from using gum joints for gas pipes. On taking up pipes that had lain in tolerably damp earth for eight years the gum rings were found to be perfectly elastic, without any indications of decomposition or softening, and they adhered so firmly to the iron that it required considerable time for four men to work the pipes apart, and in some places the gum separated instead of leaving the iron.

A petition presented to the Common Council shows that there are 55,000 unemployed laborers in New York, and that their families number about 220,000 persons, who are reduced to great destitution. The Council has asked the Legislature to pass a law authorizing an appropriation of $1,000,000 for repairing the down-town streets, now in bad condition, in order to provide these men with work. The relief societies are all overtaxed, and there has never been so much want in the city as at present.

The Secretary of the Metric Bureau writes very confidently in regard to the early adoption of the decimal system of weights and measures by the people of the United States. He says the interest in the subject is increasing every day. The substitution of the meter for the yard, and the liter for the quart, is one of those reforms which will take time; and when adopted the people will stand amazed at the fact that the introduction of a system so simple and convenient was delayed so long.

The Baltimore Iron Bridge Company has just completed an iron bridge over the Conewago creek, near New Oxford Adams county, Pennsylvania. It is on the Hanover Junction, Hanover & Gettysburg R. R. Two wooden bridges had been constructed on this road within twenty years, costing about $6,000, while this iron bridge only cost $4 0.0.

The Cincinnati Bridge Co. will soon commence the construction of the bridge over the Little Miami river on the Cincinnati & Portsmouth road, (narrow gauge) The company have just closed a contract for a county bridge at Kingston, N. Y. They are now engaged on a number of county bridges two of which were recently shipped; one to Topeka, Kansas, and one to Kokomo, Indiana.

Capt. Barrett, commanding the United States steamer Plymouth, having made a thorough examination of the Eads jetties at the mouth of the Mississippi river, reports the result to the Secretary of the Navy. The conclusion of the report is as follows: "The jetties are a perfect success. At a little expense the current which now tends to the Southwest Pass and forms an eddy, can be obviated and directed to the proper course. I hope the Department will approve of my taking the responsibility of testing the success of this work with a Government vessel." Capt. Barrett further says that at the time he passed through the jetties his vessel was drawing 17½ feet. The lower jetties were passed in eighteen minutes. The greatest depth of water found was thirty feet, and the least eighteen feet, and that too, in mid channel. The upper jetties were passed in eighteen minutes and fifteen seconds. Capt. Barrett was sent to New Orleans to assume command of the naval station at that port, and act in concert with the military forces of the Government in case of trouble. He has, as he reports, taken command and opened communication with Gen. Augur.

RAILROAD NOTES.

Bonds are to be issued to complete the Waynesburg & Washington R. R., Pa.

The Kellogg Bridge Company, of Buffalo, N. Y., have an order for five spans of iron bridges for the Houston & Texas Central R. R.

A survey is being made of the proposed line of the Toledo & Ann Arbor R. R. to Owosso, Michigan. It will cross the Chicago & Port Huron R. R. at Antrim.

The board of directors of the Missouri, Iowa & Nebraska R. R. Co., have held their annual meeting, and voted to commence work at once and push the road through to Nebraska City without delay.

The *World's* dispatches from Arizona speak of more mineral discoveries near Prescott, causing much excitement. It is also reported that a railway company, to build from Prescott to the line of Sonora, has been formed with a capital of $10,000,000 in $100 shares.

A Tucson, Arizona special says the Southern Pacific railroad bill was reported to the House from the conference committee and passed. It provides for exemption from taxation for years, and permits fixing its own tolls at not more than 10 cents per mile for passengers and 15 cents per ton per mile for freight.

A railroad meeting was recently held at Dubuque, for the purpose of furthering the interests of the Sioux City, or Northern Branch of the Pacific R. R., and its extension to the Black Hills. It is claimed that the original bill provides for this branch road, and its restoration to public notice is energetically urged. Measures are to be taken to have the matter properly brought before Congress, and the work pushed forward if possible.

During the past three months 700 tons of new rails and 100,000 new ties have been put on the St. Louis, Rock Island & Chicago road, the work being done by a special construction train put on for that purpose. It is estimated that 300,000 new ties and 2,000 tons of steel rails will be put in during the coming summer. About one-half of the ties will come from Southern Illinois and are to be delivered in East St. Louis, while the balance will be procured along the line of the road.

Not many months ago a municipal Paris deputation went to London to examine the underground railway. It has now been decided to build a similar network under Paris at a cost of 160,000 000 francs. The Seine will be crossed by two tunnels, one for up line, one for down, each enclosed in brickwork, surrounded by tubes of plate iron measuring over eighteen feet in diameter.

The Chicago, Danville & Vincennes R. R., which was sold at auction on foreclosure of the first mortgage committee representing the bond-holders. The price in Chicago, a few days since, was purchased by a paid was $1 450,000. The total indebtedness of the road is over $7,000,000, but by the terms of the decree of foreclosure this is all cut off, and the present purchasers get the road clear. It is expected that they will reorganize the company and operate the road.

Within the past week parties at the head of the movement for constructing a railroad from Quincy, Ill., to Beardstown have raised sufficient funds to defray the expenses of the final survey and location of the road. On February 13th the subscribers to the location fund held a meeting, at which it was decided to have the work commenced immediately. Engineers J. E. Blunt and C. W. Irish have arrived in Quincy, and the engineering party will be organized at once, and will commence the work of locating the road at once, after which arrangements will be perfected to begin the grading.

It is believed that the Central R. R. of New Jersey must go into the hands of a Receiver, and the question of dropping its stock from the list is under consideration. The stock fell to 18½, closing at 19¼. A year ago it was 117. At the Company's office it was stated that the fresh decline on February 10th was without just reason, and that no transfers have been made, notwithstanding the large quantities reported to have been sold. There is little confidence left, however, in the management, and Wall street was full of rumors all day. As a last appeal the Company has sent out circulars asking stockholders to subscribe without guarantee towards its new certificates of indebtedness. To add to the embarrassments, the engineers announced an intention to strike on the 12th inst. unless they were paid back wages, which they claim from November, and which amount to $160,000.

The St. Louis Railroad Journal says: The building of the great railway from Vera Cruz to the city of Mexico was a colossal feat in constructive engineering. The intervening country was superbly beautiful, and crossed at right angles by the great Sierra mountain range, through which is one continued panorama of beauty. The railway is 267½ miles long, has eighteen lengthy tunnels and many fine iron bridges. It cost the grand sum of 40,000,000 Mexican dollars, and is undoubtedly the finest constructed railway on the American continent. The first forty miles is straight, and on a gentle grade, rising slowly from the sea; then, for a distance of seventy-five miles, it crosses over three distinct ranges of mountains, each of which stands up like a colossal staircase. This section is very crooked. Winding around the numerous canons in the mountains, the train runs for many miles over the very brink of precipices, almost perpendicular, 3,000 feet. The grades are 400 feet per mile. The company use an English engine—known as the Farley patent—which carries ten loaded cars with ease. It is a double engine, or two engines connected, with their heads turned together, and thirty-inch drivers. At the west end of this division, which is at Boca del Monte, the road-bed reaches its greatest elevation, which is 13,000 feet above the sea at Vera Cruz; from there it gradually declines through a continuation of broad valleys to the city of Mexico. These valleys are from three to twenty miles wide, entirely hemmed in by tall mountains. Every foot is irrigated, and in a thorough state of cultivation.

A CORRESPONDENT, one of the leading bridge builders of the country remarks of the Ashtabula bridge;—"The characteristics af that unfortunate structure are becoming pretty well known. It seemed to have been built in defiance of some of the first principles of the art."

ARCHES;

CONSIDERED GRAPHICALLY.

[Copyright 1877.]

(Continued from page 42.)

28. Recalling the three conditions of equations (4.) (6.) and (7.) it will be evident that, while it will be possible to adjust the two lines of the curve of equilibrium to their proper position by successive trials, it will not, as in the former case, be easy. The three ordinates A I, G N and B L can, however, be computed quite readily, and the remainder of the process is very simple. The statements so far made apply to a structure of any outline, so long as it acts as an arch, although some modification will be called for when the cross-section and the depth vary very much, or when what is known as the moment of inertia is not practically constant; but, for forms other than regular curves, the application of these conditions must probably be made by trial.

29. Before taking up for treatment any arches of special curves, we will notice the simple case of a rib, of any form, hinged at both ends and the middle, or, as it is sometimes called, the "three hinged arch." For such an example it has been stated that the curve of equilibrium is at once definitely located. If a single load is placed at K, on the arch A D B of Fig. 5, hinged at A, D and B, one of the two straight lines composing the curve of equilibrium must, starting from A, pass through D, while the other, starting from B, must meet the former on the vertical line drawn through K, as required by §1; A C B therefore is the curve. If 2-1 represents the weight at K, and 2-0 and 1-0 are drawn parallel to C B and A C, 0-3, drawn horizontally, will give the horizontal thrust, while 1-3 and 3-2 will be the vertical components of the reactions at A and B. Let it be remembered that the total reaction of the abutment at A is, and is in the direction of, 1-0, although it is often convenient to decompose it into P_1 and H.

A load vertically below E will similarly have for its curve of equilibrium A E B. For different positions of the weight between D and B, all of the vertices of the curve will plainly be found on the straight D L, and the portion A D does not change for any movement of the weight on the right half of the arch. A weight on the left half would simply reverse the diagram. The dotted lines show the curves of equilibrium for a weight at such successive points as divide the half span into five equal horizontal parts, and the corresponding changes in the value of H will be seen in the stress diagram on the left.

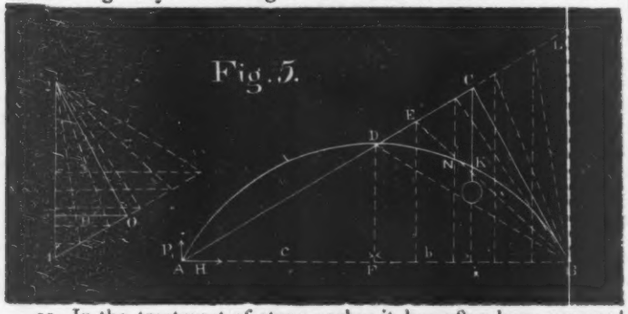
30. If the height or rise of the arch, F D is denoted by k, the half span, A F = F B, by c, and the horizontal distance F G, from the weight to the middle of the span, by b, we shall have A G = $c+b$, and G B = $c-b$. From the similarity of the triangles A D F and 013 we may write

$$3\text{-}0 : 3\text{-}1 = c : k, \text{ or } H : P_1 = c : k.$$

By the usual rule, $P_1 = \frac{c-b}{2c} W$; therefore,

$$H = \frac{c-b}{2k} W \qquad (8.)$$

The quantity $c-b$ is to be understood to mean the horizontal distance from the weight to the nearer abutment. H is seen to decrease regularly as the weight moves from the middle of the span.



31. In the treatment of stone arches it has often been assumed that the curve of equilibrium passed through either the middle of the depth of the keystone or some other arbitrary point within the middle third of its depth, and a similar assumption would then be made for the springing points. Such a treatment immediately reduces the stone arch to this case, and the curve of equilibrium can then at once be drawn. As such an assumption does not seem to us warranted, it is not expedient to go into the case of the stone arch until later; but the reader who desires to look up such a mode of handling the problem is referred to the paper by Wm. Bell, already cited in § 22, where he will see how the curve of equilibrium for a definite load is constructed, the distribution of the load found which shall make a particular arch in equilibrium, and how oblique or normal forces may be taken account of.

32. We will, however, as an example, show how to draw a curve of equilibrium for an arch which is loaded uniformly along the curve. Such a distribution will conform quite well to that of the steady load on an arched roof. For definiteness, let the pointed arch of Fig. 6 be of 80 feet span, 40 feet rise, the two arcs having a radius of 60 feet, and let it be loaded with 500 pounds per foot of the rib. We may, if we please, divide the rib into a convenient number of equal portions, which divisions will give us a number of

equal weights to be laid off on the load line. Otherwise we may space off a number of equal horizontal distances. In either case, the load of each space will be considered as concentrated at its centre of gravity, and, if the spaces are small enough, the centre of gravity may, without sensible error, be taken as coinciding with the middle of each space. For the sake of reducing the number of lines, so as to prevent confusion in our small figure, we have divided the half span into four parts, of ten feet each, measured horizontally, and their centres of gravity will be assumed to be at five feet, fifteen feet, etc., from the point of support. Draw verticals through these centres of gravity, D, E, F and G.

To find the weight on each division:—The lengths of the several portions of arc may, with sufficient exactness, be considered as the same with the lengths of their chords, which chords are perpendicular to the radii which pass through D, E, etc. If then the load on ten feet is 5,000 lbs., draw $a\,b$ horizontally, and equal, by any scale, to this amount; then will $b\,g$, $b\,f$, $b\,e$ and $b\,d$, drawn parallel to the respective chords, give the amount of load on each division, or at the successive points G, F, E, etc. Upon scaling these amounts we may lay them off upon a vertical line, from 1 to 5. In order to cause the curve of equilibrium to separate from the rib sufficiently to be easily seen in this small figure, we have taken the liberty of doubling the load on D, thus making it 4-6, in place of 4-5. The loads will therefore be, successively, about 5,400 lbs., 5,900 lbs., 7,000 lbs., and $2 \times 10{,}000$ lbs., or 20,000 lbs., from G to D, and from 1 to 6. Since $H = \frac{c-b}{2k} W$, we have for its value,

$$\tfrac{1}{2} H = \frac{35 \times 5400 + 25 \times 5900 + 15 \times 7000 + 5 \times 20000}{80} = 6769 \text{ lbs.}$$

If the given load were unsymmetrical with regard to a vertical through C, it would be necessary to calculate the two vertical components of the reactions at A and B, or P_1 and P_2, the reaction at B being laid off from that end of the load line which had measured on it the load nearest to B, and then to draw a horizontal line from the point of division between P_1 and P_2, on which to lay off the value of H. But, if both sides of the roof are loaded alike, half a diagram and half a curve of equilibrium will be sufficient. The load on the half arch being 1-6, 6-1 will be the vertical component of the reaction at B, and H will be laid off on the line 1-0. Since we have calculated H for only one half of the entire load, the above quantity must be doubled, and the total horizontal thrust will be 13,538 lbs., which is plotted from 1 to 0, the direction of the resistance of the abutment at B. The reaction at B is therefore 6-0.

As this is the first example, it may be well to pause here and renew the caution to the draughtsman to lay off the polygon of external forces in the order in which the forces are found in going round the arch or truss; otherwise he will fail to make his curve of equilibrium close on the desired point. Thus, beginning at G, he will have the weights at G, F, E, etc., or 1-2, 2-3, 3-4, etc., plotted, one after the other, down the vertical load line in the direction of their action, until the point B is reached, for which he draws 6-0, from 6 to 0. Then the point A gives a similar line from 0, slanting upwards towards the right, and the remaining loads on the left half of the arch come down a vertical line and close on 1, the starting point. The decomposition of 6-0 into 6-1 and 1-0 does not alter the case. If we had gone round the arch in the opposite direction this stress diagram would have been reversed, or turned round 180°.

Nothing remains but to draw, first a line from B to the vertical through D, parallel to 6-0, then one, parallel to 4-0, from the end of the last line to the vertical through E, and so on, the last line, parallel to 1-0, passing through the hinge at C as required. The curve on the side C A will be exactly similar. It is well to have the points of division quite numerous. The maximum ordinate between the rib and the curve of equilibrium, multiplied by H, gives the maximum bending moment.

(To be continued.)

THE WATER FRONT OF NEW YORK.

The State Legislature of 1870 organized a Department of Docks for the City of New York, vesting the power in the hands of five commissioners, who should determine upon a plan for the permanent improvement of the river line, should administer on all the wharf property belonging to the city, and should regulate the whole water front. Other legislative acts had previously passed, giving power to the city to build wharves, bulkheads, etc.; but this was the first step towards the adoption of a plan of permanent improvement. Wharves and bulk-heads had been previously erected with piles or cribs filled with stone, but they decayed, slid into the river, overturned and got out of repair generally, so that they were not even temporarily satisfactory.

The engineer appointed by the first board was Gen. Geo. B. McClellan who devised the system and method of procedure which has since been acted upon. He proposed "First. To construct a permanent river wall of *beton* and masonry, or masonry alone, so far outside of the existing bulk-head as to give a river street 250 feet wide along the North river, 200 feet wide on the East river from the Battery to Thirty-first street, and 175 feet wide north of that point. Second. To build piers projecting from the river wall, of ample dimensions, adequate construction, and, so far as possible, affording an unobstructed passage for the water. Third. Whenever it is necessary, to cover these piers with substantial sheds, suitable to the requirements of each case."

This plan was adopted by the new board of the Department of Docks in 1873, upon the recommendation of Gen. Chas. K. Graham, then the Engineer-in-Chief. The river wall is composed of *beton* blocks weighing from 25 to 50 tons each, extending from the foundation to within about two feet of low water mark, and above that line of a granite ashlar facing, backed with concrete. The foundation is either of rip-rap or piles as circumstances requires. Rip-rap is leveled over with broken stone and a layer of concrete about a foot thick is laid and leveled off by divers. Piles are cut level with a circular saw and packed closely with broken stone and concrete.

The construction was commenced between Christopher street and W. Eleventh street, together with some wooden piers, this being the most northerly portion projected at present, and also at the foot of Battery Place. The wharves are intended to be generally of wood, sheathed and protected from worms and decay. Some work has also been done at Canal street. The commercial organizations in New York, interested in these improvements, having apparently become dissatisfied with their progress and the expense of the same, have been holding meetings, during the latter part of last month and the first of the current month to take into consideration the existing condition of the docks. A report of a committee taxes the present Department with extravagance and calls for a change. A second committee advocates reducing the width of West street from 250 to 200 feet, except between W. Eleventh and Canal streets, where portions of the stone bulkhead are already finished on the 250 feet line, having in view the saving of expense in filling, and the importance of leaving the river-way as unobstructed as possible; it urges that the width of the water street on the East river should be fixed at only 100 feet; and then it advocates double track freight lines on these streets for the use of all railroads having depots in the city. What the committee reports about stone bulkheads is as follows:

"We insist, further, that if these improvements are to be of practical value to the commerce of the city, and we believe them to be of the first importance, they must be completed with expedition as well as at moderate cost.

The plan under which the Department of Docks is now pursuing its labors, and which calls for stone bulkheads, would require at their past rate of progress of about 500 feet per annum, over one hundred years for its completion between Sixty-first street, North river, around to Fifty-first street, East river, the portion of the city covered by this plan. Such a plan is evidently too slow to meet present emergencies, and this, in our view, is precisely as fatal to its usefulness as the overwhelming cost of the stone bulkhead which it demands. We therefore recommend that the Legislature be petitioned for the repeal of this plan. This committee entirely coincides with the report of your Committee No. 1, in the belief that no better bulkhead is needed than is made by wooden cribs filled in with stone. Such a bulkhead can be rapidly built and at small cost. It is very durable and readily admits of repairs when necessary. This committee believes that with a bulkhead of this character the work of widening West street, which should be the first to be done, could proceed at the rate of 2,500 running feet per annum without interfering too seriously with the commerce of the port and without devolving too great a burden upon the city. This would be a rate of progress five times as great as with stone bulkheads, and, according to the figures given in the report of your committee No. 1, it would be achieved at less than one-half the expenditure required by the present plan for covering one-fifth as much space.

The present Dock Commission came into office in May, 1875. The president is Mr. S. H. Wales, and the Chief Engineer, Geo. S. Greene, Jr. They both deny the charges of extravagance. The first sub-committee found fault with the construction of stone wharves or piers. To this President Wales answers that when the present commission went into office it found the work laid out and partially accomplished.

"It was never intended by the original Commissioners to build any stone piers except the one now building at the Battery, and a corresponding one on th East River just above the South ferry. These two piers were to be a sort of title page to the rest of the work and afford an agreeable and beautiful appearance, together with the Battery wall, to those who came up the bay and visited the city for the first time. The pier No. 1, instead of costing over $1,000,000, as stated by the sub-committee has really cost but little over $600,000. It would have been finished in December last, but for the fact that the frosty weather intervened and stopped the operations. The main thing now to be done is to cover the surface with suitable material to stand the wear and tear of the trucks and other vehicles which will pass over it. The Engineer-in-Chief of this department has thought that asphalt would be the best material, and as soon as the weather would permit the work will be continued and completed. As a commercial property I do not regard pier No. 1 as possessing a very great value. The south side during the inclement season is useless for vessels, and on the north side, owing to the rock formation upon which the pier stands, there is not sufficient depth of water for vessels of the largest capacity. I also absolutely deny that the bulkhead wall cost any such sum as stated by the committee in their report. In reality the cost was less than one-third of that amount. The Commissioners have never intended to incur any such large expense as that report states by building the wall over the distance mentioned.

"It was the original intention to construct the masonry wall along the line of the water front, from the foot of W. Eleventh street on the North River to the foot of Grand street on the East River, where the largest commercial business of the city is concentrated. At the lowest calculation consistent with the proper regard for the interests and convenience of commerce, the expense of this construction would be distributed over a period of not less than ten years. It was never proposed to continue the work above W. Eleventh street on the North River or Grand street on the East River."

"Under a new and improved plan suggested by the present Engineer-in-Chief of the department, Mr. George S. Greene, Jr., the department is now constructing a masonry bulkhead from the foot of W. Eleventh street to the Battery, at an estimated average cost per lineal foot of $225. The sub-committee referred to recommend as a substitute for the masonry wall a wooden bulkhead, at a cost varying from $110 to $150 per lineal foot. No wooden bulkhead suitable for the purpose can be built for less than $150 per foot, which is within $75 of the cost of a masonry bulkhead, which would last for thousands of years."

"The difference between the time required for the construction of the masonry bulkhead as adopted by the Dock Department and that required for the construction of a wooden bulkhead of a suitable character, would be very little, as it is impossible to divert from commercial use at any one time any considerable amount of the bulkhead and pier accommodation within the limits of the district specified."

We should be very sorry to see a much needed improvement hindered, changed in plan and rendered abortive. So much of the work as has already been executed, has been carried out in a very thorough manner so as to make an exceedingly durable and handsome river wall; and, if the new improvements are made only so fast as the public interests require, but are substantial as far as they go, the burden of well directed expenditure may be so distributed over many years as to bear lightly on the citizens.

THE letter of Mr. Clemens Herschel which we reprinted from the *Boston Advertiser* in the NEWS for Feb. 3, was also copied by the *Railroad Gazette* from the same source, so that, although not originally published in an engineering paper, it has now been quite thoroughly laid before the profession. As a natural consequence, we find several letters in reply to one portion or another of his remarks. The editor of the *Gazette*, in commenting upon a communication of Mr. T. C. Clarke, recommending the appointment of a Government board of bridge inspectors which he suggests should be selected from the corps of U. S. Engineers understands that Mr. Herschel "could not conscientiously permit the erection of the pin-jointed bridges which most American bridge-builders prefer," if he should be one of such inspectors. To this Mr. Hetschel replies in the *Gazette* as follows:

"I think your editorial of Feb. 2 does my opinions alike too much and too little justice or credit. I do not object to the *pin-joint*, especially not in diagonals. But pin-joint is not the proper name for the article. Under cover of that name we are told to swallow plain butted, or cast-iron joint-box compression joints, the use of bolts and nuts that are forever rattling loose, where rivets are evidently better, cross-members laid on, when they should be firmly riveted to, the main trusses, and much more of an unwholesome character. *Let us call things by their right names*, and then judge them according to the evidence."

We copy this note because some of our readers may have understood Mr. Herschel in a similar way. We think he was not quite clear in his expressions, and might have been easily understood to object to pin-joints. The original letter has also aroused Mr. Fred. H. Smith, of the Baltimore Bridge Co., and Mr. Alfred P. Boller, who strongly dissented from Mr. H's views in the *Railroad Gazette* of the 9th inst., and later Mr. Chas. Bender, who inserts a very able article in the issue of the 16th inst. We mention these communications for the benefit of those of our readers who take an interest in such a discussion, as it would take up too much of our space to cite them here, and they can be readily found in the well known columns of our able contemporary.

MR. EDWARD S. PHILBRICK, sends to *The Railroad Gazette* some additions and corrections to the information about the Ashtabula bridge, which we copied last week.

A HOWE truss highway bridge at Elgin, Ill., having a span of perhaps 80 or 90 feet, has braces which are largest at the middle of the span, and counters largest at the abutments.

THE communication on "Cements and Concretes," which is begun on this page, will, we trust, be of interest to all engineers who have to deal with masonry construction. It is written by one who has had several years continuous experience in dealing with these materials, who draws largely from that experience, and knows whereof he writes. Therefore the facts, results and proportions given may be relied upon.

THE plan of using iron for the construction of the frames, etc., of railway cars seems to be gaining in favor, and is remarked upon in many of our exchanges. The National Tube Works, of McKeesport, Pa., are building a number of cars under the LaMothe patent, using wrought iron tubes and steel rods for the frames and trussing. As will be noticed in our review of Mr. Higinbotham's report last week, iron has been employed in car construction in North Germany and in Austria, with good results. Box cars with iron sides have been used on the New York Central R. R., and we have wondered whether the platform cars used by Barnum last year, in his travels through the States, were not built under the LaMothe patent.

CEMENTS AND CONCRETE.

BY BERNARD R. GREEN, C. E.

(Written for Engineering News.)

It is related that, many years since, a foreman on a well known public work "down east," with a laudable aim at economy and an eye to employment for his crew of laborers during an approaching winter, innocently petitioned the engineer officer in charge to be allowed to make up and store, (!) for use the following summer, a considerable quantity of concrete. Though this was clearly a case of temporary loss of sense, it may, as an extravagant example, serve to illustrate how far it is possible for the prevalent ignorance of the laws of induration of mortars to lead ordinary workmen into absurd blunders. Men were formerly more disposed to be guided by the rules of their fathers in this matter than to study and scientifically pursue methods that would make desired results certain. Far too generally the "mortar man," foreman of the pug mill," or whatever the title of the man entrusted with the preparation of the mortar, was an ignorant laborer, who, though wielding the hoe and shovel with admirable grace and skill, possessed no proper understanding of that most essential process

over which he held full sway, and who was therefore guided only by whim in bringing the material to what he considered the proper "temper." Uniform results were often wanting, and the cause of the failure was little suspected.

In earlier times but little was known of the laws governing the action of the limes, and the rules of Vitruvius seem to have been the only guides. Recently chemistry has dispelled much of the mystery, and through the researches of Vicat, of France, followed by other engineers, has thrown sufficient light upon the chemical actions involved in the manufacture and hardening of limes and calcareous cements, to admit of the establishment of such rules for the manipulation of the ever varying ingredients of mortars and concretes, that absolute failure of an ordinary work need never occur.

Recently the rapidly extending use of cements in various ways has led to a reasonable approach to a careful system of testing, proportioning, and mixing ingredients, and of finally testing and studying the product in its stages of induration.

This article has been prepared with the hope of so presenting the subject in a brief and rudimentary form as to assist inexperienced readers of ENGINEERING NEWS to an intelligent use of the materials discussed, and also that they might realize the importance of diligent experimental study before attempting their employment in an important work. Engineering literature contains much that is easily accessible on this subject.

There is yet ample field for investigation and a profitable exercise of skill, good judgment and ingenious device in the attainment of economy in the adaptation of these materials to works of construction. Study will surely tend to multiply and increase the future applications of concrete, as it has already, within the past fifteen years, brought it to an equality with the best masonry, from which it differs only on questions of cost. The cheaper production of late of the better class of cements, keeping pace with demand for a better article, has favored their more general application.

Concrete is of very ancient origin. Its use by the Romans is attested by the ruins of their works in England. From the "slime" of the Tower of Babel to the cements of to-day, mortars have been in demand and have consisted of pulverized earthy substances, from pure clay to the best modern calcareous cements, in great variety and of all degrees of value, from worthlessness to a capability of rapidly attaining the hardness of the best building stones themselves. Many of these have formed the cementing elements of concrete.

Concrete or *beton* is an artificial mixture of mortar with pebbles, broken stone, bricks, tiles, old pottery, shells, or any substances to which mortar will firmly adhere, the strength and durability of the mixture depending, of course, upon those of its ingredients, according to the proportions in which they enter. It is really a species of masonry without artificial bond, and is sometimes called concrete masonry. The coarse, inert substances incorporated are called aggregates or ballast. Formerly the term concrete was applied only when the cementing material or matrix was such that, like common lime, it could be used in open air situations only, while *beton* which contained hydraulic mortar, was fitted for wet foundations or submarine works. In England these terms were lately, if not still, applied to distinguish methods of mixing. When all the ingredients were first mixed together dry, in proper proportions, and the water afterwards added—the lime, if used, being thus slaked in the mass—the compound was called concrete; but when the mortar was made before the admixture of ballast it was called *beton*. At the present time in this country, any compound of lime or calcareous cement mortar with ballast, by any process, is called concrete, whether hydraulic or not. Hydraulic cement is, however, almost invariably used, and pebbles, with broken stone, bricks or shells, commonly form the ballast. Bituminous and tarry concretes for walks, etc., are not included under this title in an engineering sense. When properly prepared and at once compacted, it hardens, or "sets," forming an artificial conglomerate or pudding stone.

The obviously paramount importance of the cementing element, or matrix, in concrete, entitles it to our principal consideration, and we will therefore briefly sketch the characteristics of the materials chiefly depended on for this purpose, premising that, to obtain an expert knowledge of them, much study and experimental analysis are requisite.

Formerly, and especially in England, the matrix consisted of common lime, then came the natural cements (in England called Roman), and finally the Portland cements, natural and artificial. As ordinarily found in the market at the present time, these take rank, as to strength and cost, in the order named, the prices being approximately, in the Eastern States, 30 cts., 40 cts., and one dollar per cwt., respectively. The three classes include endless varieties, making the lines of division necessarily arbitrary. Portland cement, however, is much less variable than the natural products, being entirely under the control of the manufacturer. The basis of them all is pure lime (protoxide of calcium) which, though practically useless alone for mortar, is, in combination with clay and other substances, capable of hardening or "setting."

Lime is generally found in nature as a carbonate, or limestone, occurring in great variety, of all colors, widely diffused, and containing varying proportions of several impurities, such as magnesia, silica, alumina, oxide of iron, etc. The mineralogist distinguishes the varieties as argillaceous, magnesian, ferruginous, etc., if the predominating element be clay, magnesia, or iron, respectively. Other less important substances are always found in small quantities in all limestones, and exert more or less effect on the combination. Hence no two quarries yield identically the same quality of lime.

In order to obtain ordinary quick lime, the stone is subjected to a process of calcination, or "burning" (in kilns with alternate layers of coal), which drives off the carbonic acid and water, reducing the stone about 45 per cent. in weight, and from 10 to 20 per cent. in bulk, in which state it possesses great avidity for water. This process is of the highest importance in the preparation of all limes and cements, natural or artificial, one which they must all undergo, and upon the careful and faithful conduct of which depends the homogeneity of the product and its property of setting quickly or slowly. To secure uniformity in the result, each kind of limestone must be studied separately, as also the changes of weather while burning. The difficulty of the process and diversity of results increase considerably when the amount of impurity greatly exceeds that of common lime. The finer varieties of marble, for instance, yield pure lime, while ordinary limestones, containing not more than ten per cent. of the impurities above mentioned, yield what is known as common, or fat, lime. The quality of lime varies with the increase of impurities, until the more complex varieties become the so-called cements, a generic term misapplied to the products of a particular class only of limestones.

The process of calcination as generally applied to limes and cements is fully detailed in General Gillmore's "Limes, Hydraulic Cements and Mortars," the best treatise on the subject by an American, if not by any author, and to which the present writer is much indebted.

Previous to being used in mortar the limes must undergo the process of slaking, to render them more suitable for incorporation with other substances, and to prevent a subsequent swelling in the mortar and consequent damage to the work. In old lime this may have already taken place imperfectly by contact with air, but, when properly done, the result is good slaked lime, or hydrate of lime. The more of the usual impurities the lime contains, the less its augmentation of bulk in slaking and the greater its capability of hardening under water. The latter quality confers upon it the title of hydraulic lime. The ratio of lime, to the clay and magnesia together, has been termed the *index of hydraulicity*.

By the characteristics of the products of limestones developed by slaking—the power of hardening under water, etc.,—they are classified as common lime, poor lime, hydraulic lime, and natural hydraulic cement.

Common lime, also termed *fat*, or *rich* lime, is the ordinary article of commerce—that used for brickwork, house plastering, etc.,—and contains less than 10 per cent. of impurities. In slaking it absorbs about one-third its bulk of water in passing to powder, and two and one-half to three times its bulk in taking the consistency of paste. Slaking should be performed by the method known as drowning, after carefully ascertaining by experiment the exact quantity of water needed. The quick lime should be spread in a layer, 6 or 8 inches deep, and the whole of the water thrown at once evenly over it, when considerable heat and vapor will be rapidly evolved, and the mass will swell from two to three and one-half times its original bulk. If allowed to set without a large dose of sand, this paste shrinks to such an extent as to preclude its employment as mortar. The sand aids in preserving the bulk at the expense of porosity, and takes the place of lime. The hardening of this lime is mainly a drying process with but little chemical action further than the absorption of carbonic acid from the air, producing superficially a return to its original state of carbonate. If such mortar is much exposed to water, the lime is dissolved out and only sand left. It will never harden under water, and should never be employed in works of importance. Nevertheless, this grade of lime is of much value in many ways, and, when artificially treated with other substances, furnishes compounds of the highest value as mortars. A very valuable application of it is made in the production of the celebrated Portland cement, to be described presently.

Poor limes are certainly poor in every sense of the word, for building purposes. They contain impurities generally ranging from 10 to 25 per cent., swell but little in slaking, and do not yield a homogeneous powder. In other properties they are similar to common lime, but they act with no uniformity, and are generally unsatisfactory to work with. The abundance and distribution of common lime in this country renders their employment unnecessary.

Hydraulic limes are subdivided into moderately hydraulic, hydraulic, and eminently hydraulic. They contain of the usual impurities, 10 to 20, 17 to 24, and 20 to 35 per cent. respectively; slake slowly with slight rise of temperature, evolving little or no vapor; increase in bulk not over 30 per cent.; and set under water in periods ranging from 1 to 20 days, according to their position in the scale of hydraulic energy. An abundant supply of the natural cements, possessing superior qualities, is a bar to the extensive manufacture, in this country, of the hydraulic limes, but they have been largely used in Europe. The celebrated Thiel lime of France, possesses great hydraulic value, due to about 66 per cent. of silicate of lime, and its successful employment on a large scale in constructing in sea water, for which it is considered eminently adapted, has placed it quite iat the head of the class.

Natural hydraulic cements differ from the hydraulic limes in that they contain from 30 to 60 per cent. of the impurities, retaining from 70 to 40 per cent. of lime, do not slake when mixed with water, and therefore maintain a uniform temperature and bulk throughout the processes of mixing and setting. The latter quality renders their use, in a pure state, possible and often advantageous. The color of these cements is variable, due chiefly to oxides of iron and manganese, and furnishes no guide for judging of their cementing value. In this country the common dark brown or drab color has received the general confidence of workmen, who are often prejudiced against a light colored cement until convinced by experience that there is necessarily no difference.

These cements are as diverse in proportion and variety of ingredients as the hydraulic limes, both being derived from sedimentary rocks, and hence unremitting caution must be exercised by the manufacturer in the selection as well as the calcination of the stones, requiring both honesty and a judgment begotten of large experience. Homogeneity, rapidity of setting, and ultimate strength of the product are thus greatly influenced. It is, however, common in this country to find cements that are good at all stages of calcination. Few manufacturers have carefully studied the different layers in their quarries, and it is common for them to use all the stone quarried and trust to empirical mixing to obtain desired grades of cement. The calcination in kilns similar to those for lime, is usually stopped below the point of vitrification to facilitate the subsequent process of grinding and to increase the hydraulic activity. The calcined stones are next passed through a cracker, which reduces them to pieces the size of a pea, and finally pulverized between French burr millstones. Here again it becomes necessary to the perfection of the cement that the requisite power be wisely and honestly expended, as the degree of fineness affects its strength and capacity for sand in mortar. Cements always greatly differ in this respect. To ensure very perfect chemical action in hardening, they should be reduced to an impalpable powder of which at least 92 per cent. will pass a sieve of 6400 meshes to the square inch. When ground they are at once packed in barrels, 300 lbs. to each, lined with paper to prevent loss and contact with air, and are then ready for the market.

The rapidity of setting steadily declines from the time the cement leaves the mill. It sometimes sets in three or four minutes and may occupy as many hours, but the best quality sets in from fifteen to thirty minutes. Quick setting is produced by under burning and is not an indication of ultimate strength. The activity and even the property itself of hardening may be preserved for a length of years only by total exclusion of air and moisture. Exposure to the air in the ordinary barrels favors the absorption of moisture and carbonic acid, producing carbonate and hydro-silicate of lime, etc., sufficiently to seriously lower its hydraulic activity and strength in a few months, and in time to neutralize them entirely. If, however, such ruined cements be moistened and mixed in small balls with about ten per cent. of clay and recalcined by subjection to a red heat for 1½ to 2 hours, their valuable qualities may be restored. It is not uncommon to find cements, containing an excess of free lime, that are safer to use when six months old than when freshly ground.

This general description of natural cements applies more particularly to those of this country where they have been extensively used. Until within a few years, when the artificial so-called Portland cement began to be imported, they were almost exclusively depended upon at all important works in masonry or concrete, in water or on land, large amounts being used by the government engineers. Deposits of stone, furnishing them, are found in great quantity in the United States, principally in the eastern sections, much of it of superior quality. Some of the finest stone exists and is worked in Pennsylvania and Virginia, but Ulster county, New York, is the principal source of supply, being situated near the Hudson river, in easy communication by rail or water with all parts of the sea coast and interior of the country.

The cements manufactured here are among the best of their class for works in salt water, due to a large percentage of magnesia in combination with silica and alumina. Their hydraulic induration is largely due to the partial formation, during calcination, of silicate of lime, subsequently completed by the agency of water when made into mortar.

The variations of composition to be found in the Rosendale cements is shown in the following:

Silica, clay and insoluble silicates,	11.10	to 39.74	per ct.
Alumina	2.34	to 7.50	"
Peroxide of Iron	0.76	to 5.38	"
Carbonate of Lime	28.43	to 46.00	"
" Magnesia	14.43	to 39.04	"
Chlorides of potassium and sodium,	1.68	to 7.42	"

Hydraulicity is assisted by the presence of the last named substances. These cements weigh about 70 lbs. per struck bushel. An excess of lime is detected if heat is developed, when mixed with water, but more delicately if they swell and crack while setting.

The Roman cement of England was first prepared there in 1796. Its name is said to have been derived from the resemblance of its mortar to that found in the Roman ruins. It is similar to the Rosendale of this

country, but is considered somewhat superior in hydraulic activity and final hardness, though not ground so fine.

ARTIFICIAL HYDRAULIC CEMENT.

We will confine our description of this class to that member of it which has so recently risen into deserved prominence, and which is known as Portland cement, a name probably suggested by its resemblance, in color and texture, to the Portland stone of England.

This cement was originally manufactured and introduced on a small scale in Europe rather more than fifty years ago, but lack of appreciation of its merits and probably the cost of production prevented its extensive use until within twenty years, during which time it has rapidly grown in favor and now ranks above all other calcareous cements. It is a double silicate of lime and alumina, produced by artificially assembling the proper proportions of desirable elements, to the exclusion of the injurious ones always present in the natural cement stones. While Roman cement requires only a few days for its manufacture, the Portland occupies two months or more. But little has been made in this country. Possibly the higher cost of labor, and the lack here of suitable clay and the soft and peculiarly adapted chalk of England, will continue to prevent successful competion with English makers.

The English Portland cement is composed of chalk and clay, though limestone, shell, etc., may be, and are used, more or less, as sources of lime. The process of manufacture is comparatively simple, good results being unerringly ensured by the exercise of reasonable care and watchfulness. These are first required in the selection and digging of the clay, a labor that is therefore entrusted only to the most reliable workmen kept constantly employed at it. All impurities, as sand, vegetable mould, etc., must be strictly avoided.

Analyses of ingredients are given as follows:

Fair sample of clay.		*Thames chalk.*	
Silica	68.45 per cent.	Lime	56.5 per cent.
Alumina	11.04 "	Carbonic acid	43.0 "
Carb. lime	0.75 "	Water	0.5 "
Oxide iron	14.80 "		
Alkali	4.00 "		

An analysis of a good sample of the finished cement should give calcium 62, silica 23 alumina 8, and oxide of iron 4 parts.

There are two principal processes followed at different works for the manufacture of Portland cement, distinguished as the "wet" and "dry." By the wet process, most used in England, the clay and finely-sifted chalk are mixed together in proportions of about 1 to 3 by weight, and ground with water under edge runners. It is afterwards allowed to settle for some time, when the surplus water is drained off and the mass subsequently nearly dried upon drying stoves. After being kneaded into balls about 3 inches diameter it is burnt at a high heat in an ordinary kiln to a point verging upon vitrification, and finally ground between millstones to an impalpable powder. By the dry process, which is more generally practised in Germany,—being better adapted to the working of the harder limestones,—the clay and carbonate of lime are dried and then reduced to an exceedingly fine powder by passing, as may be required, successively through a stone-breaking machine, edge runners, and horizontal mill-stones. The ingredients are mixed together in proportions varying from 20 to 23 per cent. of clay, and 80 to 77 per cent. of carbonate. The powder is wrought with water into a stiff paste and formed by machinery into bricks which are dried and then burnt at a barely vitrifying heat, by which their weight is reduced 40 to 50 per cent. The bricks are finally ground to powder as in the wet processs, the stone-breaker and other machines being again required here to effect the reduction. Success in burning depends, as with the natural cements, largely on the judgment of the burner.

Unlike the natural cements the Portland does not deteriorate by exposure to common dry air, but, on the contrary, it is better to defer packing the freshly ground cement to allow a short period of airing. It is imported in barrels about the size of those for Rosendale cement, though, from the greater specific gravity and closer packing of the Portland, they weigh one-third more, or about 400 lbs. each.

Two chief causes of the superiority of this cement are, the intimate homogeneous mixture of the chalk and clay, and the close approximation to vitrification in burning. Competition and the high quality exacted by English engineers compel the more responsible and larger manufacturers, at least, to constantly employ skilled chemists who frequently analyze the materials and preserve accurate proportions.

At Boulogne in France is found a natural deposit of soft calcareous clay containing the proper proportions for good cement, and which may be excavated with the shovel. It is probably the only similar deposit worked. The material is burned as for the Portland cement above described, yielding what is known as Boulogne Portland cement. Being strictly a natural cement it might have been so classed here. It is alleged to possess a strength slightly superior to that of Portland proper, but requires from twelve to eighteen hours to set.

The more uniformly the calcination is effected at the proper temperature throughout the mass, the greater will be the weight of the cement,—a highly desirable quality. This may vary from 90 to 140 pounds per English bushel, and the time of setting, consequently, from 10 minutes to perhaps two days. Quick setting is gained at a sacrifice of strength, while the heavier cements are more costly to produce. The English standard of quality combines three distinct tests, namely: weight, 110 lbs. per struck Imperial bushel loosely measured; fineness, sufficient to pass a sieve of 1600 to 3000 meshes per square inch; strength, 200 lbs. tensile per square inch, when seven days old, first day in damp air and balance in water.

The facts, that an increase in weight of 24 lbs. per loose bushel, say from 100 to 124 lbs.—obtained by a well managed high temperature in burning,—nearly doubles the tensile strength; that extreme fineness is a very important desideratum in all limes and cements; and that the specified tensile strength can be easily conferred with the other qualities, show the necessity for, and fairness of, such a standard. Cement of such a quality may be said to set in about three hours, although it begins to stiffen somewhat sooner; attains a reliable solidity in not less than a day or two; and becomes very hard in a week. In three months its hardness exceeds that of ordinary bricks, and in a year is equal to that of the strongest sandstone, marble, and even some of the granite. The color of Portland cement is no sign of quality, being usually greenish grey in the English and often a pale reddish tint in the German grades.

The experiments of Smeaton and Vicat, showing that good hydraulic cements harden and improve with much greater advantage under water than in the open air, have been fully confirmed. Portland cement mortar is, in fact, impaired in strength if not kept moist, or better, under water during the period of induration. Small moulds, in which such mortars are deposited, should therefore not be opened to expose the surfaces to drying air under three or four days, though the mass may have sufficiently set to maintain its form.

The volcanic products known as puzzuolana and trass formerly much employed in Europe, in combination with lime, for mortar, call for no more than a mention here. They are hardly to be found in this country, and even in Europe have been largely superseded by the modern cements. Their action is, moreover, attended with uncertainty.

(*To be continued.*)

CORRESPONDENCE.

CORRECTION.

NEW YORK, *Feb. 14th, 1877.*

Editor ENGINEERING NEWS:

SIR.—In ENGINEERING NEWS of Feb. 10th, which is remarkably full of good engineering meat, I notice a little error in your brief paragraph on page 36, referring to a report upon Rapid Transit, etc. You say the "Gilbert Elevated, etc." It is not the Gilbert, which is a different plan entirely, not yet built. It is the "New York Elevated Railroad," that is doing a large and increasing business.

Your journal ought to be getting subscribers, if they come in proportion to what you give for the money.

W. MILNOR ROBERTS.

We may note that we were corrected on the same subject by Mr. J. J. R. Croes of New York city, but his letter was mislaid before getting into type.—[ED.

OTTAWA, ONT., *Feb. 15th, 1877.*

Editor ENGINEERING NEWS:

SIR.—In your issue of 3d inst. is a letter from Mr. LeBarron, on a mode of keeping levels I would gladly see introduced on this continent.

It is the system I have always used and seen used in England; and I have endeavored in vain to introduce it here. It is the only *safe* and *scientific* way of keeping levels, for each reduced level depends on the preceding, and at every change of instrument the leveler can check the reduced heights, whereas by the mode of working from "height of instrument" there is no check at all.

In the example given in your paper there is a very good test of both English and American systems. On looking over the levels I unconsciously applied the check and found an error of 0.040, *which could not have been found by the American system.*

TABLE OF LEVELS.

Station.	Back Sight.	Intermediate	Foresight.	Rise.	Fall.	Reduced Levels.
0	7.408					284.364
1		6.57		.838		285.202
2		5.70		.870		286.072
3		5.64		.06		286.132
4		5.50		.14		286.272
5		5.52			.02	286.252
6			5.217	.303		286.555
	6.671					
7		6.13		.541		287.096
8		5.28		.85		287.946
9		5.24		.04		287.986
10		3.93		1.31		289.296
11		3.93				289.296
12		4.20			.27	289.026
13		3.28	3.28	.92		289.946
	14.079		8.497			
			Diff. 5.582		Diff. 5.582	

In the above table my rule for checking, which I apply both to every change of instrument and at the bottom of each page is simply this:

1. Add the backsights and foresights together on every page and take the difference. This should be the same as the difference between the first and last reduced level on the page. The last reading on the page is always used as a foresight. Thus:

7.408+6.671 = 14.079
5.217+3.280 = 8.497

Difference..... 5.582
Elevation at top of page.....284.364
" bottom " 289.946

Difference..... 5.582

2d. By taking the difference between the back and fore sight at each change of instrument a check is obtained, viz.:

B. S = 7.408 F. S = 5.217, difference, 2.191
Elevation, 284.364 286.555, " 2.191

From this the rule is obtained:

When foresights are subtracted from backsights there is a rise of levels: When the reverse occurs there is a fall.

There was an error in the example given by Mr. LeBarron. In the 4th foresight 5.64—5.50 = 0.100 as printed, instead of 0.140, and the error of 0.040 is carried all through the column. Had he applied my system of checking he would have discovered his error at once.

In the foregoing table I have made up the levels, according to the form used in England.

In my practice in Canada I have found several errors in Bench marks, traceable to the error of reduction from "height of instrument," which could not have occurred had the levels been reduced on the system proposed by Mr. LeBarron.

ALAN MACDOUGALL.

ROCHESTER, N. Y., *Feb. 14, 1877.*

Editor ENGINEERING NEWS:

SIR—I notice that your correspondent, Eliot C. Clarke, of Boston, in his communication of Nov. 8, 1876, calls attention to Kirkwood's modification of Prony's formula for the discharge of water through pipes or sewers. He says: "Kirkwood, for instance, modifies Prony's formula from

$$\text{Disch.} = 38.08\sqrt{\frac{D^5 H}{L}} \text{ to } 38.08\sqrt{\frac{D^4 H}{L}}$$

varying as the square root of the diameter, or in a 9-ft. sewer, as 3 to 1.

Kirkwood, in his report on the Brooklyn Water Works, gives the formula as follows: $m = 38.08\sqrt{\frac{D^5 H}{L}}$ which he changes to $D = \left\{\frac{m^2}{1450\,S}\right\}^{\frac{1}{5}}$ where m = cubic feet per second, D = diameter in feet, and S = the head divided by the length.

In his remarks on Mr. Roe's tables, he says: "Mr. Roe takes a rainfall of one inch the hour as his standard in the above table."

"The formula already given was $D = \left\{\frac{m^2}{1450\,S}\right\}^{\frac{1}{5}}$

"When this is make applicable to acres it becomes $D = \left\{\frac{m^2}{5804\,S}\right\}^{\frac{1}{5}}$, m standing for acres."

"When the last form of formula is altered to, $D = \left\{\frac{m^2}{5804\,S}\right\}^{\frac{1}{6.4}}$ it will be found to approximate very nearly to the diameters given in Mr. Roe's tables."

"To simplify the root of the formula and to insure its always giving results somewhat in excess of Mr. Roe's tables, I give it the following form: $D = \left\{\frac{m^2}{5804\,S}\right\}^{\frac{1}{6}}$ where it is desired to apply it to the areas in acres—and where it is desired to apply it to the cubic of discharge at any point, governed in that case by the length of streets delivering to that point as heretofore explained, the formula becomes $D = \left\{\frac{m^2}{1450\,S}\right\}^{\frac{1}{6}}$ "

I fail to perceive how the length of the street affects the diameter of the pipe as long as m remains the same. If m = 10, for instance, the diameter must be sufficient to carry 10 cubic feet per second without regard to the length of street it has passed over to arrive at the sewer.

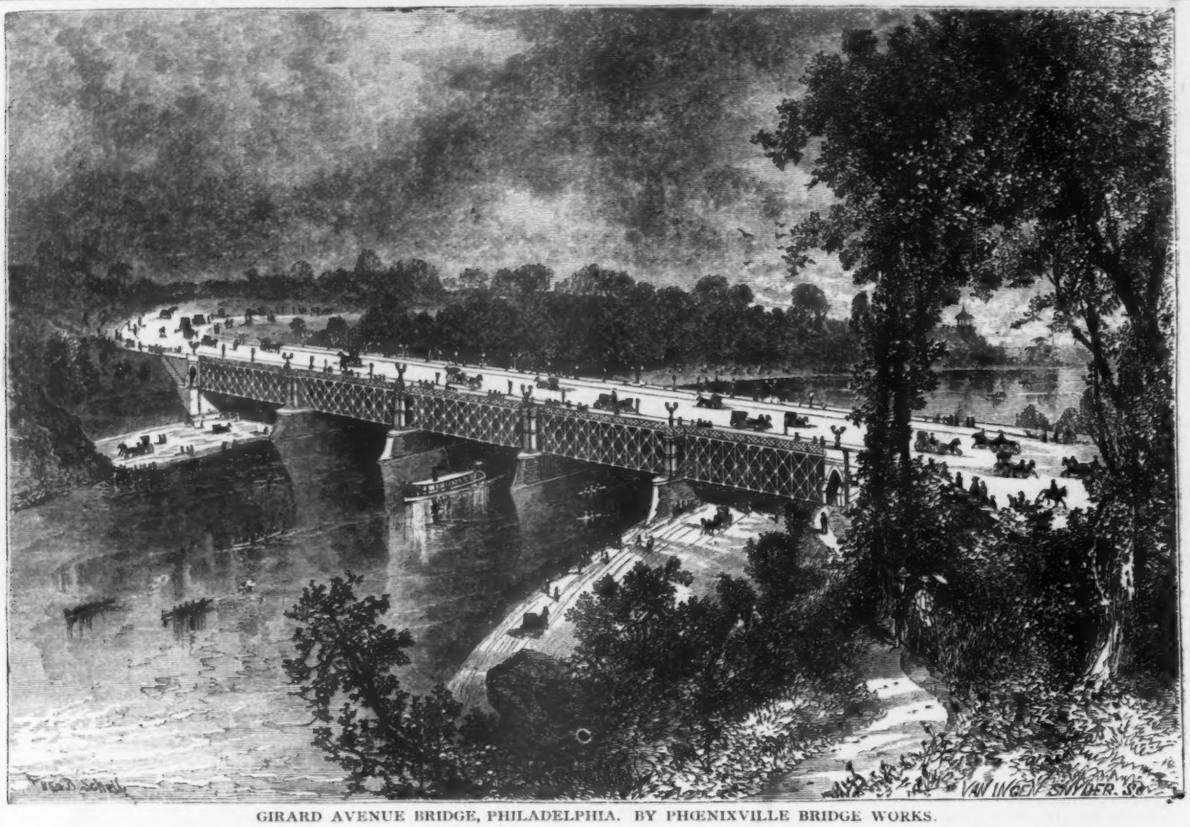
Mr. Kirkwood quotes a formula from Bazalgette for determining the diameter of a sewer sufficient to carry off one inch of rain per hour per acre.

One inch of rain per hour per acre = 1.00833 cubic feet per second per acre.

In applying his formula to Mr. Roe's tables. Mr. Kirkwood, by his modified formula makes a pipe 26 inches diameter with a grade of 1 in 240 sufficient to drain 50 acres, which, according to the explanations = 50.41 cubic ft. per second. Now Prony's formula, which he modifies, would make the capacity of that pipe 8.56 cubic feet per second.

Mr. Kirkwood has substituted n for m in his formula, and then modified it to conform to Mr. Roe's tables of actual experiments, and then has applied the same modification to the original formula, which is erroneous; because m refers to a definite quantity in a definite time, but n refers to a definite number of acres, but a varying time, because the greater the area drained, the greater distance must the water travel to arrive at the sewer, and therefore a greater time.

The distances which the water has to travel to reach the sewer will vary as the square root of the area drained, and the time of its passage to the sewer will



GIRARD AVENUE BRIDGE, PHILADELPHIA. BY PHŒNIXVILLE BRIDGE WORKS.

vary in the same ratio, so that Mr. Kirkwood's modification of the formula with n as a factor is right and proper, but is not right when it contains m as a factor.

I therefore conclude that the formula $D = \left\{\frac{m^3}{1450\ S}\right\}^{\frac{1}{6}}$ is erroneous.

L. L. NICHOLS.

SPECIFICATIONS FOR THE IMPROVEMENT OF RAPPAHANNOCK RIVER, VA.

1. *Locality.*—The location of the work is on the Rappahannock River, at Fredericksburg, Virginia.

2. *Dredging.*—A channel nine feet deep at low water and fifty or more feet in width, is to be excavated through portions of Fredericksburg Bar between Deep Run and the railroad bridge. The material to be excavated is sand. The depth of cutting varies from two to four feet.

3. *Deposit.*—The excavated material will be deposited behind the several dikes, or on the banks of the river, at a varying distance from the work of from thirty to five hundred yards. For a small portion of the dredging (about 2,500 cubic yards) this distance may be seven hundred yards. Light-draft shoveling scows will be required for this purpose. They must be provided with sides, which shall always be used. The scows can be poled by hand and the dikes reached at all stages of the tide. The material will be deposited at an average distance of one hundred feet behind the face of the dikes (for which work an ordinary scraper may be used) and must be leveled off at such height as the Engineer may designate.

4. *Depth.*—The depth of the channel when completed shall not be less than nine nor more than ten feet at low water. If less than nine feet is found the channel must be re-excavated until that depth is obtained. Excavation below ten feet will not be paid for.

5. *Construction of Dike.*—A dike is to be built on the right bank of the river, below the steamboat wharf, in the following manner:

A. *Dredging.*—The line of the dike is to be dredged to a width of five and a depth of eight feet at low water, where required.

B. *Piles.*—Along the line designated for the face of the dike oak piles twenty-two feet in length and one foot in average diameter are to be driven, ten feet apart from center to center. Parallel with and ten feet in the rear of the front row, a second row is to be driven, the piles to be also ten feet apart from center to center, and to stand at right angles to the corresponding piles on the front row. The piles in the rear row are to be of oak twenty feet long and one foot in average diameter. A fender pile of the dimensions specified for the front row is to be driven at the middle of each bay. All the piles are to be of live timber, sound and straight, and are to be sharpened and well and carefully driven so as to stand plumb and true to the line. Each pile shall be driven so that it has its full length below the level of the top of the dike, which is six feet above low water; the top of the pile shall be cut off at this level. The contractor will be required to band the tops of the piles during driving, if found necessary.

C. *Wale pieces.*—After the piles have been suitably notched to receive the same, two wale pieces are to be bolted along the inside of the front row of piles. The upper wale is to be of pine timber, 6 inches by 12 inches, in lengths of at least twenty-one feet, set so that the upper edge shall be four and a half feet above low water. The joints are to be halved and to come on the piles. The wale is to be bolted to each pile with a 1-inch iron bolt, with nut and washers, and 20 inches long, and to be spiked thereto with two 10-inch ship-spikes (9-16ths inch square) of wrought iron. The lower wale is to be of pine timber, 4 inches by 8 inches, in twenty-one feet lengths, set so that the upper edge is at low-water mark. The joints are to be halved and to come on the piles, and the wale is to be spiked to each pile by two wrought iron ship-spikes 9 inches long and 9-16ths inch square. The two wale pieces will break joint, and the inside faces must be in the same vertical line.

D. *Sheet piling.*—The sheet piling is to be of three-inch heart-pine plank eighteen feet long. The piles are to be sharpened and carefully driven along the inside of the wale pieces, and the tops neatly sawed off at the level of the top of the dike, the piles to be of the required length below this level. Every other pile is to be driven against the wale pieces, and the intervening piles are to be driven behind these so as to lap three inches on each edge and form a close joint. Each sheet pile is to be spiked to each wale or to each adjacent sheet pile with two wrought iron spikes 6 inches long and 3-8 inch square, four spikes being used in each sheet pile.

E. *Ties.*—After the sheet piling has been driven, the corresponding front and rear piles are to be connected by tie pieces of pine timber, 6 inches by 12 inches, in lengths of twelve feet, with square ends, bolted to each pile with two 1¼-inch wrought iron bolts 20 inches long, with nuts and washers. The piles and sheet piles are to be suitably notched to receive the ties.

F. *Material, etc.*—All the timber for sheet piles, wale pieces, and ties is to be of the best heart-pine lumber, free from wind, shakes, or any other defects. The iron for the bolts is to be of the best quality of wrought iron. Holes of the proper size are to be bored for each bolt, and for large spikes when required. All the material and work is to be satisfactory to the Engineer or Inspector, and such as does not fully conform with these specifications will be rejected. Moreover the dike when completed shall conform to the plan of the same in the office. The dike will be estimated by the lineal foot.

6. *Quantities.*—The estimated amount of excavation is 20,000 cubic yards; of dike 350 lineal feet, more or less. These amounts are approximate, and may be increased or diminished as the funds require.

7. *Tides.*—The mean range of tides is three feet. The locality is entirely sheltered.

8. *Machinery.*—All machinery must be adapted to the work and kept in good order. The scows must be sound and tight.

9. *Inspector.*—An Inspector will be appointed by the Engineer, who will act as his agent in the immediate charge of the work. In accordance with the instructions of the Engineer, he will indicate the special locality of dredging and deposit, and supervise the construction of the dike, and will enforce strict compliance with the contract and specifications.

10. *Measurement.*—The excavated material will be measured in scows by cubic contents. The Engineer shall determine the capacity of each scow, and the Inspector will determine when the scows contain full loads, and keep a record of the same.

11. *Lines, etc.*—The precise location of the work will be fixed by the Engineer in charge. The exterior lines of the channel will be plainly marked by stakes or ranges, and no dredging done outside these limits will be paid for. Intermediate ranges, if desired, must be set by the contractor. The Inspector will set tide-gauges at convenient intervals, and the contractor will be held responsible for any loss or delay arising from injury to stakes or gauges by his own employes. The contractor will be required to supply lumber for stakes to mark the direction of the channel, and also furnish labor for setting the same, and for the necessary examinations and soundings, under the direction of the Engineer in charge—the expense of the same to be included in the price of dredging.

WE present this week an illustration of the Girard Avenue Bridge, Philadelphia, erected by the Phœnixville Bridge Works. This is also one of the plates serving to make the work on Iron Highway Bridges, by A. P. BOLLER, C. E., at once as attractive as it is useful and instructive.

AT the annual meeting of the American Microscopical Society of the city of New York, held Tuesday evening, January 9th, 1877, the following officers were elected for the ensuing year: *President, John B. Rich, M. D., 1 West 38th street, New York; *Vice President, Wm. H. Atkinson, M. D., 41 East 9th street, New York; Secretary, O. G. Mason, Bellevue Hospital, New York; *Treasurer, T. d'Oremieulx, 7 Winthrop Place, New York; Curator, John Frey, Bellevue Hospital, New York.

*Re-elected. O. G. MASON, *Secretary.*

ON Monday night last, the 19th inst., a fire, originating in the frame buildings over which the great St. Louis bridge passes, at its eastern approach, seriously damaged some 300 feet of the structure itself—according to the latest advices. The *St. Louis Globe Democrat* of the 20th, after referring to the usual hitch in the water supply says: "The rookeries took fire and so did the bridge, and the latter, the pride of St. Louis, is impassable and likely to remain so for some time, by reason of a gap of some 900 or 1,000 feet in the eastern approach. All that remains of this portion through which the fire passed, are the braces and uprights, every particle of combustible material having been burned away." Loss on the bridge at the lowest possible figure is estimated at $125,000.

MANUAL EDUCATION BY SCHOOL SHOPS.

The subject of technical education, especially as pertaining to the thorough instruction of young men in the mechanical trades, seems to be very generally engrossing public attention. The endeavor of the Massachusetts Institute of Technology to establish instruction shops, where not only the students already pursuing scientific and engineering studies in the professional classes shall be taught all the elements of workshop manipulation in iron and steel, but also special students, desirous of acquiring a trade shall be trained systematically, so as to acquire in the shortest time that dexterity in the use of tools which characterizes the master workman, has been noticed approvingly by the press. Unfortunately another project, set on foot by Mr. Ruggles, endorsed by Wendell Philips and Professor Watson, formerly an instructor at the Institute, and advocated before the Social Science Association and through the papers, has seemed to conflict with the first, and, as both schemes are urged before the Massachusetts Legislature, with the petition for a grant of public aid to equip, and support for the present, the desired shops, a collision between the two has been brought about which otherwise seems unnecessary.

The course of instruction at the Massachusetts Institute of Technology is modelled upon that of the Imperial Technical School of Moscow, a description of which we gave at some length in Vol. III., No. 47, for November 18, 1876, and we would refer to that article for a detailed description. In the preceding number, of November 11, we gave our opinion of the utility of industrial schools as compared with the now, we may say, almost obsolete system of apprenticeship, and we will not therefore repeat here our favorable endorsement of the former. The distinction drawn by President Rumkle of the Institute between *instruction* and *construction* shops is, in our opinion, well made. In the first case the shops initiated at the Institute, the pupil is set to work on a task which embodies some principle in its simplest form, such, for example, as filing a piece of cast-iron accurately to a straight line and plane surface. When this operation is successfully performed he is advanced to another. In this way he rapidly progresses, so that he can soon shape with the file any desired and possible surface or form. There is then no need of further instruction in that work, and he is set at tasks which call for the use of other tools. Metal working, forging, pattern-making, moulding and fitting are all intended to be pursued, under the eye of an expert in each branch.

It is objected by some that the students are put to work on *junk*, and that it is junk when they get through with it. In other words, such persons want the young men to *make something*. It appears to us that a workman can learn more quickly to handle a tool so as to produce a required result when there is but one thing to take his attention, than when there are several operations to be carried out successively, on the same piece, in order to complete a finished, merchantable product. We doubt whether the students of the Mechanical Engineering Department of Cornell University were any less proud of the *true planes* which they exhibited at Philadelphia, and which any machinist could appreciate, than they were of their lathe or engine.

Then Professor Watson takes a ground of opposition to the Russian plan, or to the Institute plan, that the students are required to perform work with hand-tools that could be better done by existing machines. This has always appeared to us a very curious objection. We have no doubt that the Professor could make a truer surface on a piece of cast-iron in a planer than with a file in a vise, but that is no argument that he had not better learn to handle a file and to file true, if he were to desire to become a machinist. All machine tools have to be fashioned by the aid of other tools, and the formation of dies, gauges, templates, drills, and an endless variety of the implements used in the shop, requires hand labor. Why is it that the die-sinker or the fitter-up, the model-maker and men of this class can command high wages? Because men who have trained eyes and hands are scarce in machine shops. There are an abundance of young men who can tend a lathe or planer, run a machine-drill or a screw-cutter, but very few comparatively who are competent to get up the original patterns, designs and tools for the work in hand. We have worked in a machine shop long enough to understand the difference between tending a machine and working by hand. It may cost $400 or $500 to make an accurate working model of a breech-loading rifle, for instance, and several months to get up the dies, tools, and gauges for the manufacture, with the employment on such work of only first class workmen, but when the manufacture is once under way, the guns are turned out by thousands, at a cost of from perhaps $12 to $15 apiece, by men who get often no more than $2.00 a day. If we cannot get our master workmen to make a beginning, who will lay out the work for the common run of hands?

If a shop is to turn out finished work and to be self-supporting, the students must be kept more or less at routine tasks, carrying numbers of the same piece through one operation, which they can do as well when they have performed it two or three times as when they have turned off parts by the score or hundred. How students can be rapidly advanced, according to proficiency, in a shop where construction is the object we fail to see.

As the *file* was spoken of at some of the public meetings in a contemptuous manner, as being an obsolete instrument, it may be worth while to read the statement of one competent to judge, after an inspection of some of the students' work:

Mr. H. P. Langley, a mechanic of thirty-five years standing, after examination of a specimen of fitting made wholly by the file, stated that such skill was to him marvellous, and he believed it would be hard to find a mechanic after two years' work in the machine shops who could do such work as these lads have done in a week. He also stated that it was absurd to say to any one acquainted with mechanical operations that the use of the file was obsolete; it is in many respects the best and the only instrument that can be economically employed, and it always will be.

However, the proposition of Mr. Ruggles really has a different scope, and is independent of the Institute plan. An abstract of what is designed to be accomplished is as follows, taken from a committee report to the American Social Science Association, published in the Boston *Post*:

DEVELOPING SCHOOLS AND SCHOOL SHOPS.

The importance and the value of a practical training in the education is first emphasized, after which the Committee say that the laborer must now receive a different practical education from what was required two generations ago. Apprenticeship having departed, never to return in its ancient form, something else must take its place and give to our artizans practical instruction. By the old apprentice system the boy was bound to the master some seven years, and received his instruction more by his own observation than by any direct teaching. We recommend the plan suggested by Mr. S. P. Ruggles, and so universally endorsed by the press, in contradistinction to the former system of our fathers—that the youth, whenever he has completed his general education in any of our public or private schools, may enter what may be called a developing school, so established and arranged as to give all the pupils a good general idea of all the different trades, arts or callings, in order that it may be ascertained by themselves for the Superintendent for what kind of business they have the greatest natural genius. Imagine, if you please, one very large room with a steam-engine and boiler in the middle of it, so that all pupils that have any taste for the management of steam or steam engines, could examine every point, and readily understand all about it. Then we would have a carpenter's bench, with a variety of tools, to show how that work was done; then perhaps turning lathes, to show how the wood-turning business was performed; then with the aid of blackboards and carving tools, it might be seen how drawing and carving is done by those that have any inclination for that business. We should also have planing machines, lathes, upright drills, jig-saws, etc., to represent the machinist business. Foundry work should be shown by having the usual fixtures for sand, and two and three part flasks for moulding, etc.; the casting could be done in soft metals, as lead, zinc, or tin, which could be reused, as the whole art in foundry work consists in the different manner of moulding, and almost all other trades or methods of doing work could be pretty well represented in the same room. As soon as it should be ascertained what kind of business the pupil is best fitted for by nature, he would be recommended to the school shop where that trade should be taught, and be more thoroughly instructed in two years, and become a better mechanic, than in six or seven years under the old system of learning a trade.

After showing the difference between the mechanical shops of all kinds that should be established to teach a trade, art, or calling, and the shops already established for doing work of that particular kind, for profit, the Committee say there should be a very particular selection of the kinds of work to be made at the school-shops, consisting of lathes and planers and other tools that are always kept on sale, large and small work of different kinds, making as great variety of work as possible for the pupil to practice on.

In the school shop the pupil would advance from a lower degree of instruction to a higher as rapidly as his thorough knowledge and good workmanship would justify. The instructor would be paid a satisfactory salary, and not be permitted to make merchandise of the time of the student. All machinery or articles made by the students could be put on sale or be sold at auction, and the proceeds appropriated towards defraying the expenses of the school shops.

After commenting on the importance of changing the system of mechanical education in shops, and dwelling on the advantages of divisions of labor, which make men specialists, the Committee say: "We have planing mills, where boards are planed by the wonderful "planing machine" to an equal thickness; tongued, grooved and jointed if desired; also, machines run by steam for sticking out mouldings of every size and description. There are special establishments for making blinds, sashes and doors of every description and variety. Stair building, formerly a part of the carpenter's trade, is now a specialty or business by itself. Great changes have taken place in the machine business, caused by the subdivision of labor and the introduction of various machines to perform the labor formerly done by hand. Instead of chipping and filing to make a straight edge or level surface, the material is now placed upon the planer for planing iron, where the edge is made perfectly straight, or the surface perfectly level, in one-fourth the time formerly required before the introduction of the planing machine. This is true of other varieties of work, by means of upright drills, jig-saws, screw-cutting apparatus, polishing and emery wheels, universal chucks and other appliances to the lathe, together with other apparatus which facilities the manufacture of the various parts of the work. It is well known there is no place at the present, nor has there been for some time past, where a boy could "learn a trade."

We are pleased to learn, say the Committee that we have the hearty approval and co-operation of Mr. John D. Philbrick, the experienced Superintendent of the Public Schools of Boston, in relation to the above-proposed plan. In order to prevent misapprehension by those who have desired information in relation to the many articles published upon this subject in our public papers during the past year, we would wish to be distinctly understood that it is the object of the above plan to give to all the youth leaving our public or private schools the opportunity of obtaining a perfect knowledge of his chosen trade or occupation in the shortest possible time. Every boy, rich or poor, is, we think, as much entitled to have a good trade as to have an education in our public schools. We also believe the proposed plan would be self-supporting in a short time after being once put in successful operation. The Committee recapitulate their report thus:—

First, there would be a great advantage gained by selecting the right youth (by the developing school) for the right business; second, the boys would be taught the trade instead of getting their knowledge by observation, as was the case formerly, as it would be the whole object of the master to teach the boys, instead of making profit on their work; third, the school shop should be much more perfectly fitted up (as described) to teach the business than any shop now in operation to do work for profit; fourth, the worth of the work made by the boys would probably pay current expenses after a very short time.

THE DETROIT TUNNEL.

THE projected methods for tunneling the Detroit river increase wonderfully in number under the stimulus of an invitation from the committee to submit plans. We have lately alluded to several which have been offered, and, since our last writing, have heard of a number more. Gen. Smith's plan has been examined by the committee appointed by the Mayor of Detroit, and has been pronounced feasible. Mr. D. Farrand Henry presented plans made in 1874, when this subject was before discussed. Mr. William Scott and Mr. Henry Collins both propose tunnels, in different locations, the former putting the cost at $2,500,000, and the time two years, and the latter making his figures $2,268,000, at which sum he offers to contract to excavate it. Mr. Hall, of Mt. Clemens, proposes to sink a boiler plate tube, coated with tar and gravel to make it impervious to water. Mr. H. M. Cargill, of Grand Rapids, proposes to bore a tunnel with an earth auger, with appliances for removing boulders and other obstructions, working his machinery by compressed air. He estimates the cost at $2,500,000. Mr. McWilliams, whose scheme we alluded to on February 10, reckons the expense ot $150 per lineal foot, the tunnel to be 22 feet in diameter. Oliver Drouillard desires to sink iron tubes weighted with masonry on either side, at an estimated cost of about $200,000. Then there is a plan for an underground hydraulic tunnel, though what that is we fail to guess. Still another ingenious inventor proposes to solve the difficulty by quite another method, that is to bridge to and from Belle Isle, and to build a canal through the island for the benefit of vessels. Mr. Lu-

ther Beecher thinks that he can tunnel underground for $100 per foot.

Mr. John Burt, the chairman of the committee, proposes to start directly from the Michigan Central Railroad depot, thence to curve to the foot of Woodward avenue, and thence to cross the river directly, making a length of 5,280 feet. This plan contemplates the construction of a double-track tunnel, in caissons from 100 to 200 feet in length, across the entire bed of the river, the tunnel to be made of brick, in a timber caisson, with temporary bulkheads, floated out, manœuvered by tugs and sunk in line by means of guide timbers attached to the caissons already down. When bottom is reached, access is to be had to the caisson by iron shafts, the water is to be forced out by compressed air, or to be pumped out in case the caisson has taken the bottom sufficiently to exclude the water, and then excavation is to be carried on beneath until the caisson with its included tunnel is lowered to the required depth in the trench. He proposes to run hydraulic cement into a cavity left in the brick-work at the joint in order to make this portion tight. Then, finally, Mr. Coats, of Kalamazoo, has come forward with a scheme of which we have learned no particulars.

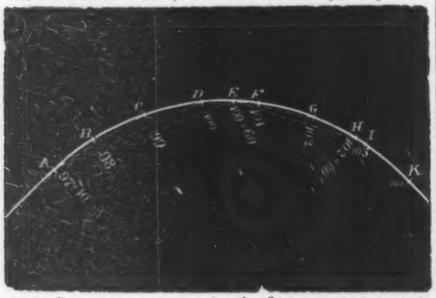
But enough of these projects, some of which are more curious than practicable; we will only say that Mr. Chesbrough has again given his opinion to the committee that a tunnel can be constructed for $3,000,000, leaving out of consideration the value of real estate which might be taken for approaches. As to the pecuniary prospects, they are favorable to the venture. New York capitalists have signified that at least $2,000,000 can be obtained on tunnel bonds at 6 per cent. interest, if guaranteed by the city of Detroit. It seems to be the general opinion that Detroit can well afford to devote $500,000 to the project. Mr. Joy stated that he would be willing to promise that the railroad companies would agree to use a tunnel, provided one was constructed, and to pay annually $200,000 in tolls. Steps for organization of a company have already been taken, and we hope that, upon the definite report of the committee, the matter will be vigorously entered upon.

METHOD OF KEEPING NOTES OF RAILROAD CURVES.

Written for "Engineering News."

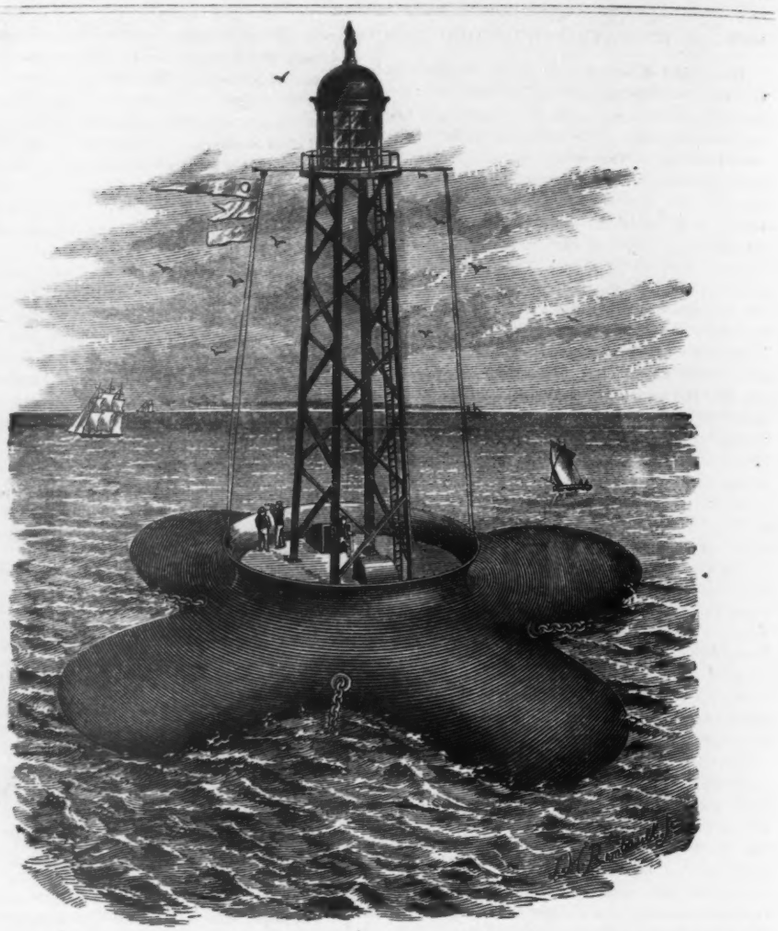
We offer, for the approval of railroad and other engineers, the following method of setting off the angles and keeping the notes for any curve, believing that it will commend itself by its simplicity and convenience for general application.

Having arrived at A on a tangent we propose to set out a curve to the right of say 2° 40′ curvature. With the instrument at A we turn off as usual the deflection angles till we locate the point E, to which the transit is to be carried forward. If A is, as marked, station 97+10, the deflection for 98 will be 1° 12′, for 99, 2° 32′, for



100, 3° 52′, for 100 + 60, 4° 40′. It now the transit is placed at E, one generally, having set the plates at 0°, sights at A, reverses the telescope and turns off 4° 40′ + 32′ or 5° 12′ for F, then 6° 32′ for 102 and 7° 36′ for 102 + 80; when the instrument is again moved to H, we should turn off the number of degrees from E to H plus the 16′ necessary to strike I.

But suppose that, before sighting at E, we set the plate at the original reading for E, or 4° 40′; then we may turn off 7° 36′ + 16′ or 7° 52′ to put in I, and can then advance as usual, adding 1° 20′ for each one hundred feet. The advantage is that each station may have its deflection worked out at once in a regular series, starting from the beginning of the curve, and the figuring in the note book may be done before the curve is run at all, as soon as the tangent point is located,



leaving only the routine to be observed that *when you sight at any point the plate must be set at the reading for that point* in the note book. Then, whenever it is necessary to put in a plus station, the number and reading will be simply interpolated in the proper columns. If one is obliged to skip any station and put it in later from another portion of the curve, to back in a portion or to re-run it, the notes require no alteration whatever. The notes are below.

Sta.		Reading
E. C.	104	9° 12′
	103	7° 52′
P.	102 + 80	7° 36′
	102	6° 32′
	101	5° 12′
P.	100 + 60	4° 40′
	100	3° 52′
	99	2° 32′
	98	1° 12′
B. C.	97 + 10	0

It will be seen that the readings run regularly and smoothly on, increasing by 4° every 300 feet.

As an illustration, suppose that we desire to set up at G, sight at E and put in the stake at C; the reading at E, station 100 + 60 is 4° 40′; clamping the plate there, sight E, turn the plate to 2° 32′ for station 99 and we shall cover C. To get on to a tangent at any point, after the plate is set for, and the telescope sighted at any point, simply set the plate for the reading which belongs to the station at which the instrument stands. The telescope need never be reversed, but can be turned on the vertical axis until the vernier reads the desired angle, thus eliminating any error of collimation. The simplicity of the computations and notes, if the rule above italicized is observed, is our reason for preferring this method.

FLOATING LIGHT-HOUSES.

It is now nearly twelve years since Mr. John Moody an English sea captain took out letters patent for a vessel that was to be used for the purposes of "Floating Electric Telegraph stations and Light-ships for mid-ocean and the English and other channels." The vessel shown in the annexed engraving, excited considerable attention at the time, and the merits of the invention were presented to the English people by the public press and by the personal labors of Capt. Moody, from whose address before the Inventors' Institute in London we propose to quote quite literally. Patents were taken out in this country through the agency of Munn and Scott, and by them described in the *Scientific American*. Otherwise we are not aware of the publication of anything in this country respecting this novel structure. Capt. Moody retired from ocean service to give his entire time and energies to the perfection and introduction of his invention, but died before seeing any realization of his hopes. The labor of bringing the matter before the several governments, who might be supposed to be interested in such a project has since devolved upon Mr. J. M. Emerson, now a resident of Chicago, by whom a model and drawings of the vessel were exhibited and explained at the last meeting of the Civil Engineers' Club of the Northwest, and from whom we have obtained the particulars, and the use of the plates, for the present article. Capt. Moody in his address says:

"Assuming then, that my form of vessel is adapted for floating mid-ocean telegraph stations—which I hope to prove before I close this paper—and taking as an example an Atlantic cable, I would suggest that such a cable should be carried in short lengths by means of my floating telegraph vessels, constructed expressly for the purpose. The first of these vessels I would place somewhere in mid-channel with a cable from the Land's End. The next vessel I would place off the Western Islands, and would place a third off the Coast of America, from which I would carry the cable direct to New York.

By this means the length of the entire cable would not be increased, whilst it would be divided into several short lengths, giving the following general advantages:—

1. The diameter and weight of the cable would be considerably lessened, thereby diminishing the cost of the cable.

2. These shorter lengths could be carried out and laid by a smaller steamer than that employed in laying the present cables, thus very considerably reducing the cost of laying the cable.

3. These shorter cables, should they break, could be repaired or replaced with a new length in a much shorter time, with much less labor, and at a greatly diminished risk and cost than in the case of a cable stretching from shore to shore.

Now even supposing that the cable laid in lengths was only intended to be used at its shore ends for through messages, such a plan would undoubtedly possess the three last mentioned advantages; but when it is considered that these floating stations can be utilized for the various purposes I shall hope to develope before I close this paper, the use of such stations is at once apparent.

Among these latter advantages are the following, to which I beg to call particular attention:—

Ships could call, and masters could communicate with their owners, whether in England, France, or the Continent, on this side the cable, or in America on that side. Masters on a trading voyage, and a long time out, would thus be enabled to send home letters and papers giving full information of the results of their voyages. For it is no idle assertion to make when I say that these mid-ocean stations could be made available for post-

offices as well as telegraph stations. Arrangements could be made with the mail steamers to call for letters and anything else that might be left at the stations.

By means of these stations, money and bills could be transmitted from masters to owners.

Large quantities of all kinds of stores and provisions could also be kept there for sale to passing ships and to relieve shipwrecked people who might be picked up, or who in open boats had succeeded in gaining the station.

News of wrecks or disasters at sea, could be sent through the cable, and assistance might be obtained for many a ship which otherwise would be lost. Life-boats should be kept at these stations (built upon the same principle as the telegraph ships, somewhat modified, that is, with four rays or arms, which would render them free from liability to upset), for the purpose of saving life, rendering salvage services, and as a means of communicating with passing ships; so that all these floating stations would thus become not only places of business, but places of refuge in the very midst of the ocean. These stations could be boarded in all weather, for from their peculiar form they could always be approached on the lee side, where the sea would be much broken, and perfect safety in boarding secured.

In fact these stations might be made the centres of communication between all nations by a simple system of cross cables; as, for example, in a cable between here and America, the first or mid channel station might have short cross cables to England and France, the next station placed off the Western Islands, could have a short cable carried to the principle island in the group, putting it in communication with America, England, France, and the whole Continent of Europe; and what could be done in that case in that ocean, could be done in all other cases, and in all other oceans and seas, until the whole world became connected together.

ACCOUNT OF AN EXPERIMENT ON A CONCRETE ARCH.

Abridged from "Der Civil Ingenieur."

[FOR ENGINEERING NEWS.]

The following described experiment was made by Prof. Clericetti, of Milan, in 1871. The arch was built by a cement manufacturing company for the exhibition of that year, of which it was one of the notable sights. The dimensions were as follows:

	Meters.	*Feet.*
Span	8.08	26.51
Rise of Intrados	1.95	6.40
Depth of crown	0.095	0.31
Length of skewback joint	0.28	0.92
Width of abutments	2.00	6.56
Clear height of abutments, to springing of arch	0.65	2.07
Breadth from face to face	0.50	1.64

The arch was constructed of cement (from Val Seriana, manufactured in the same way as Portland cement) gravel and sand. At the close of the exhibition, it was given to the Royal Institute of Milan, at the request of Prof. Clericetti, to be experimented upon; the cost of the experiment was also borne by the cement company.

The experimenter had wished to submit the arch to the conditions of a highway or railroad bridge, by a horizontal permanent load; and then to test it by rolling loads. Such, however, were forbidden, as well by their cost as by the time they would consume, the arch being erected in a public place.

The test consisted in loading the arch gradually with common brick, laid without mortar, until breaking occurred. A solid wooden scaffolding was erected beneath it, and this with the arch, was enclosed by plank walls to protect passers by. In order to observe at each moment the movement of the crown, an iron plate, moving between guides, was suspended therefrom by a wire, so as to follow this movement. The arch was divided by vertical lines a half meter apart, so that the points of ruptare might be quickly and easily located.

The bricks used for the test weighed 228.5 kilogs. (503.7 lbs.) per hundred, and one cubic meter contained 680 bricks. One cubic foot, therefore, weighed 97 lbs.

After the curve of the intrados had been measured, Nov. 17th, the loading was commenced by a load over the abutments and the extrados of the arch, of four courses of bricks. These first courses formed an arch of themselves, which was afterwards destroyed by making a hole through them 5 c. m. (= 2 ins.) wide. *a* Fig. 1; this was afterwards increased as the arch compressed more and more.

Nov. 29th, the load at the crown had reached 58 courses, or a height of 2m.9 (=9.51 feet). It became necessary to interrupt the loading twice this day, for the purpose of lowering the scaffolding, which was a difficult operation. The crown had lowered at this time 18m.m. (=.059 ft.) The next morning it was found that the arch had sprung and snapped the wire suspending the plate, owing to the swelling of the guides by the rain. The platform was lowered again and an additional load of five courses placed on the arch. The curve of the arch being now measured as exactly as possible, it was found to have lowered about 5 c.m. (= .164 ft.), mainly during the night. Immediately after this, the first trace of rupture was observed as follows:

1st. A crack, exactly at the crown, in a nearly vertical position, which opened a little at the intrados and extended into the arch 3 c.m.(= .098 ft.) This crack extended only 10 c.m.(= .328 ft.) from the front face, and was not visible on the other face. This was a result, probably, of a distortion of the arch caused by unequal drying, which threw the faces out of vertical planes. This distortion was noticed before the commencement of the test.

2d. A crack in the opposite direction, viz., from the extrados inwards, near the left abutment (see Fig. 1), midway between the division lines 3.5 and 4. This crack about 7 c.m. (= .23 ft.) long curved upwards, and could be traced on the extrados from one face to the other, but upon the rear face was hardly visible.

3d. The first indications of a crack, in the neighborhood of the right abutment, at the division line 3.5.

The arch thus showed a tendency to rupture at three points by tension. The loading was continued until

92 courses had been placed, on Dec. 2d, when a photograph of the arch was made. When the loading had reached 107 courses, corresponding to a height of 5 m 4 (= 17.72 ft.), the following was noticed:

1st. That the crack at the crown had increased, so that the unsevered part was only 5c.m. (= .164 ft.), and was the same from face to face.

2d. That the crack near the left abutment had still extended itself in a curved, unsymmetrical line (see Fig.), and that the unsevered part of the arch was reduced to a third of the normal depth of the arch.

3d. That the crack near the right abutment had extended and curved upwards, as in the other half, and that the unbroken part was reduced to a third of the normal joint. It was not possible to measure exactly the extent of the crack, as the opening at the extrados was only a few thousandths wide, and the end of the crack could not be located very nearly.

A few hours after these observations were made, the arch fell during the night of December 2d. The next morning the arch, its loading and scaffolding were found a heap of broken bricks and snapped timbers, from which nothing could be learned except that the distortion previously noticed was not without influence on the fall; part of the arch having fallen vertically, while part was thrown out of line, over the scaffolding, which must have been then standing.

REUBEN SHIRREFFS, C. E.

SOUTH FRAMINGHAM, Mass.

CORRESPONDENCE.

CHICAGO, ILL., *Feb. 22, 1877.*

Editor ENGINEERING NEWS:

SIR:—G. W. P., of Kansas City, asks for information about the economy of heat in the steam engine, and then makes the statement that the gases of combustion leave a boiler with an absolute pressure of 65 or 70 pounds per square inch. This is a remarkable statement; for if there were any such pressure as this, it would run an engine without any steam being required. As blast furnaces carry only from four to five pounds pressure to the square inch, it is of no use to say anything more about his 65 or 70 pounds.

With regard to the heat of the escaping gases, he is nearer the right thing, but is somewhat too low in his statement; for, with the heat of the steam in the boiler at 300° it follows that the gases entering the chimney must be hotter, the variation depending upon how hard the fires have to be worked to keep up the supply of steam, and the harder the fires are worked, the hotter will be the escaping gases.

Then he says: "Suppose that steam at a temperature of 300° is admitted to the smaller cylinder of a compound engine, and then is expanded to a temperature of 200° in the larger one, the result," he says "is a loss of 100° temperature." He speaks as if this were all lost, but it is out of this 100° that all the useful effect is realized, and it is this that has to be attended to to get an economical engine.

Now let us see what has become of this 100° of heat—we shall have to use the word heat, as temperature only expresses intensity—but the heat of steam is a positive quantity, for the heat that will make one pound of water one degree hotter, is equivalent to the work of raising 772 pounds one foot high.

For simplicity we will take a single cylinder engine; say the cylinder has a capacity of six cubic feet, and that there is admitted into it one cubic foot of steam of 75 lbs. pressure; to this will have to be added the pressure of the atmosphere, 15 lbs., making 90 lbs., and this is expanded to the full extent of the cylinder, and say it has lost 100° of temperature. The above cubic foot of steam contains six cubic inches of water, and has lost 100° of heat; or six hundred inches have lost one degree; six hundred divided by 27 gives 22.2 lbs. of water one degree hotter: 22.2 × 772 (Joule equivalent as above) gives 171,384 pounds raised one foot high, and if the operation took one minute, then 171,384 divided by 33,000 gives 5.2 horse power as the energy expended by the expanded steam. This is the total energy: but what has become of it? Part has been used to draw a train, or propel a boat, or do some useful work; and some of it has leaked through the cylinder, or passed through the sides of the cylinders by conduction and radiation, and it is to prevent this that the steam jacket is used—a thing he inquires about, and of which much could be said if this were not already too long.

C. R.

BOSTON, MASS., *Feb. 26, 1877.*

Editor ENGINEERING NEWS:

SIR.—Allow me to congratulate you on the improved appearance of ENGINEERING NEWS; I like the paper better every week.

How would it do to call out the practice of *surveyors of work* and their rules of thumb for measuring plastering, brick-work, etc., etc? These rules vary in different localities, and all engineers are obliged to bend to *custom* in these matters as things now stand.

J. FRANCIS LEBARON.

PORTAGE, WIS., *Feb. 23, 1877.*

Editor ENGINEERING NEWS:

SIR.—Business for the year past has been the worst I have ever witnessed, but I cannot afford to do without your paper. I am no longer Co. Surveyor. I would not run for the office last fall, nor do I intend running for it again. I agree with you in a desire to see the office abolished, or something done towards compensation. Our laws allow only $3 per diem and mileage, whereas your state allows $6.

I find that there are no less than ten surveyors and civil engineers in this county, five of whom are qualified to use the transit and level. I have used the transit on all surveys since 1856, but am the only one that does; the present incumbent is a compass man, who was my predecessor and who, together with *his* predecessor, only recorded one survey during their two terms (four years) of office, and I do not think that I did five surveys more than I should have done, through being the County Surveyor.

H. M.

NEW LONDON, WIS., *Feb. 28, 1877.*

Editor ENGINEERING NEWS:

SIR.—The original plat of the village of Waupaca, Wis., and the several additions, were originally surveyed by several different surveyors. Twenty years of undisputed possession gives title to land in this state. In 1856 the village Trustees ordered a surveyor to make a re-survey and map of the whole village. His survey differed materially in some respects from the original surveys; but it has never been disputed by action at law, or by legal process. Ques. Must a surveyor at present conform to said survey, or must he give heed to *original* boundaries, if any are found?

B. F. D.

Wherever *original* boundaries can be indisputably proved we think they will govern present surveys. A village, town, or city council have no authority to rectify a recorded plat without the consent of the owners, and any survey authorized by such a body will not affect well authenticated original boundary lines.—[ED.

KEOKUK, IOWA, *Feb. 27, 1877.*

Editor ENGINEERING NEWS:

SIR:—In Trautwine's Engineers' Pocket-book (1874 edition), p. 275, foot note (on Trusses), he says: "De Volson Wood, Professor Civil Engineering, University of Michigan, objects to the writer's 'calculations on strains in bridge trusses.' The professor sent his reasonings on the points, but they were, unintelligible.'" I think you would likely benefit a number of your readers by giving either Prof. Wood's or Prof. Greene's views in an *intelligible* form, so that ordinary readers (and Mr. Trautwine) can understand them. Trautwine truly says in his preface, that most of the writings on mechanics and engineering are not intelligible to any but accomplished mathematicians. In foot note p. 196, he says that to advertise and sell such books (referring then to Prof. Moseley's writings, and others) as being adapted to use of practical men, is sheer swindling. See also foot note p. 198; also foot note p. 286, referring to Rankine. Trautwine suggests, p. 292, that professional journals be the medium of reporting observed cases of decay of timber by the *contact* of various kinds. In foot note, p. 342, he says: "We know of no book to which a practical man can refer for any such information as we here endeavor to impart on this subject—pressures in stone bridges." There are many other hints in Trautwine's *practical* work to which I could refer you, but the above will suffice to show how your valuable enterprising journal will, no doubt, be a desiderated medium of ventilating such matters and keeping the profession and other interested persons *early* informed of the most recent information on all such pertinent matters, so that they shall not have to wait for new books or revised editions to issue to disseminate such knowledge.

Keokuk is talking of waterworks, also a revival of the Keokuk, Iowa City & Minnesota R. R., the construction of which has been for some time in abeyance. The car shops of the St. Louis, Keokuk & Northwestern R. R. are likely to be established here if the city will grant the site. The gas question being in order. Keokuk citizens think $4.50 too high for that commodity, and want a reduction. The river is open here and packets are running to St. Louis.

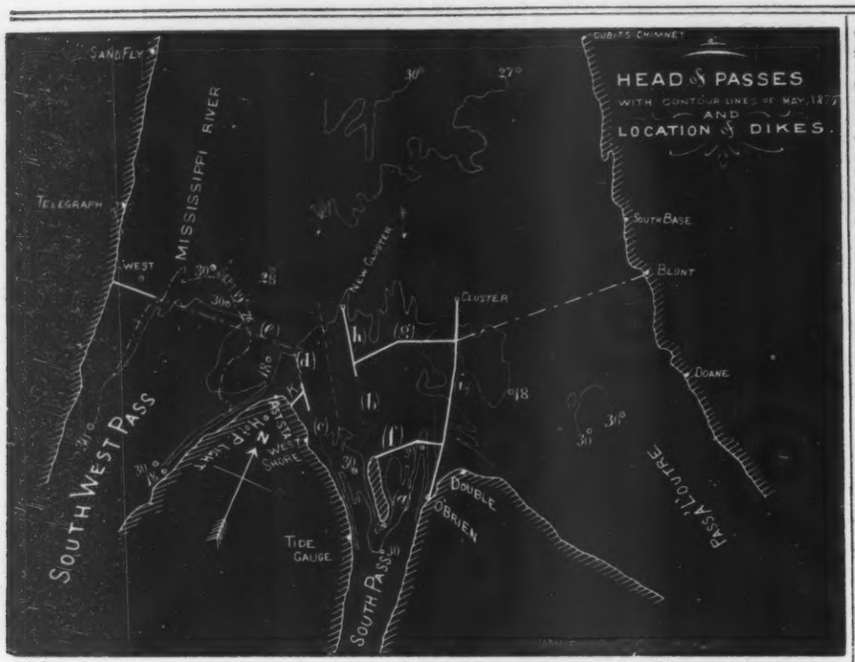
ALEX. BLACK.

NEW YORK, *Feb. 28, 1877.*

Editor ENGINEERING NEWS:

SIR.—The prospects in New York seem to be quite hopeful for the summer. Business men now say they are only waiting for the politicians to settle their little differences and then, as soon as warm weather comes, they believe all business will take a fresh start and become very brisk indeed. Engineers share also in this hopeful feeling. Quite a number of engineering projects will probably be hatched out by the warm weather and agitated for the next few months; labor on a number of suspended works may be revived again and those in operation will be pushed forward with renewed vigor.

The work, under General Newton, of removing harbor obstructions has been discontinued through the winter, owing to the ice in the harbor. But it is expected to begin again soon with renewed activity. A great many people supposed that, with the successful explosion at Hell Gate, last fall, the work was finished, and, as soon as the fragments were removed, the way would be clear for all vessels to enter our harbor from that direction. Unfortunately, though, that is not the case. The work accomplished by General Newton is but the first grand step towards the solution of the question of a second entrance to our excellent port, for vessels of all sizes, which will place us several hours nearer European ports, but it is only one step towards the attainment of this end; millions must still be expended. The next point of attack is to be Flood rock, where considerable work has already been accomplished. General Newton had laid out his plans for this summer, and made his estimates for this work. Unfortunately Congress did not see fit to furnish half the sum which he felt was necessary to complete what he wished to accomplish; he expects, though, to do more with the sum received than at first seemed possible. The only result of the niggardliness of Congress will be that New York will be obliged to wait so much longer before its harbor is perfected. It does seem a pity that Congress will be so miserly in furnishing money for such works of national importance as this, and at the same time be ready to squander millions in subsidiz-



ing railroad companies which would inevitably collapse on account of their worthlessness, if the Government did not step forward and furnish them with the cash to perform the work and afterwards present them with the ownership.

Since the injunction against the New York Elevated Railroad has been set aside, laborers have been working night and day to extend the road from its former terminus at the foot of Greenwich street, across the Battery to South Ferry. The company evidently fear a *coup de main*, and wish to prevent it by finishing the road. It is expected that cars will be running across the Battery by the end of the week.

In the meantime the other projects for rapid transit are languishing; some from legal difficulties, and some from lack of funds. Everybody desires rapid transit, but nobody wants the roads in his street, and will fight it as long as possible, if there is any danger of its coming there. t seems, however, as if the question of rapid transit for New York were to be solved by a general system of elevated roads and not by underground roads as in London, owing to the great difference in the cost of the two systems.

Work on the East River bridge progresses slowly. The foot bridge from anchorage to anchorage has been laid for over a week, and persons crossing at Fulton Ferry have usually had the opportunity of watching the progress of somebody walking along unconcernedly, two hundred and fifty feet above them. A few reporters have taken the trouble to cross on this foot-bridge in order to see what their sensations would be. One of them said Mr. Martin, the superintendent, gave him permission because he did not expect the reporters would give him any peace until they had all gone over, and some half a dozen had broken their necks by falling off or jumping off. The foot-bridge is for the convenience of the workmen in going back and forth while engaged in forming the great cables.

City work seems to be very quiet just at present. Nothing is heard of any works of importance. The good inhabitants are becoming very anxious to see some signs of the proposed bridge over the Harlem river at One hundred and thirty-eighth street. But all such works take time, and cannot be driven.

The bridge at Poughkeepsie also begins to look like a reality, although at one time it was doubted whether it would ever be more than a project. The first caisson was successfully launched a fortnight ago, and this will be followed up by more work.

Brooklyn has lately been called up n to mourn the loss of one of its most esteemed citizens, Mr. Cyrus P. Smith, the President of the Union Ferry Company, and formerly President of the Brooklyn City Railroad Company, a man who has been one of the most instrumental in the rapid growth and prosperity of the city, by his liberal policy in providing all the facilities possible in his powerful position for the rapid, convenient and safe communication between the two cities of New York and Brooklyn. May his successor prove to be as valuable to the interests of the City of Churches as he has been. E. A. R.

PORT EADS, LA., *February 16, 1877.*

Editor ENGINEERING NEWS:

SIR.—I regret my inability, for want of time, to give you a full and detailed history of the construction of the works at the head of the Passes, and of the results thus far attained. I will give you briefly a few explanatory statements to make the accompanying chart intelligible.

Referring to the illustration below, with works noted by letters, (*i*) was built first, a substantial dyke, and intended to deflect into South Pass some of the volume of Pass a L'outre, but the result was not as favorable as was anticipated, and it was decided to select the worst channel as the one to be improved; but as the works should be tentative, they were not built in a permanent manner. *f*, *g*, *h*, and *k* were constructed by laying a foundation mattress and erecting on it a mattress tilted against a row of braced piles. Those works demonstrated that the right plan had been adopted, although they were by no means water-tight, and allowed nearly half of the volume to pass through them.

The general principle lying at the foundation of the plan was this: "Slope is the measure of friction, and generally the measure of velocity: increase the slope and you increase the velocity also the frictional power of the current, and also its abraiding and erosive and carrying power." Imagine a water-tight dam thrown instantly across the head of South Pass; what would be the result at high river with a fall to the gulf of say two feet? The Pass or the level of the water immediately *below* the dam would at once drop to the level of the gulf. The water immediately *above* the dam would be raised *above* its normal height, as the other two passes could not accommodate the volume shut out of South Pass, they being filled their whole length and area by their own volumes. This would give us a head of water of say three to four feet. Now remove the dam as quickly and what is the result?—an extraordinary deepening through the shoal.

Again, we have learned that a funnel-shaped entrance is objectionable; we therefore *narrow* the entrance to South Pass, and make the entrances to the other passes as much funnel-shaped as possible.

The dams *f g k* being temporary, a permanent dam was built at *a*, one is now being constructed at *b*, one is built at *d*, and a sill 70 feet wide laid across S. W. Pass at *e* to preven deepening by the head of water made above our contracting works.

The river rose on the 27th of January, reaching half flood at New Orleans on the 4th of February.

At the jetties, and through the whole length of the Pass, the channel is rapidly improving. steamers and sailing vessels drawing twenty feet are passing out without any trouble, and present indications show that we will very soon have a deep wide channel, and a permanent one also, between "New Orleans and the sea." E. L. CORTHELL.

[*Written for Engineering News.*]

CEMENTS AND CONCRETE.

BY BERNARD R. GREEN, C. E., PORTLAND, ME.

(*Continued from page 53.*)

The setting of hydraulic limes and cements in presence of water, occurring with greater or less activity, is a kind of crystallization, combinations taking place between the lime, magnesia, silica and alumina. Water here assists in the completion of a chemical action that is begun during calcination, the greater part of it, when in proper proportion, being thus chemically combined. Induration in hydraulic mortars proceeds simultaneously throughout the mass; its permanence is proved by the experience of many years. The chemical actions involved, so far as understood, are explained in treatises on the subject. With Portland cement it makes little or no difference whether fresh or sea water be used; with the natural cements fresh water gives greater strength, but the mortar may be immersed while soft in salt water. In any case mixing with salt water is liable to result in efflorescence upon the surfaces of open air works. We may mention here that the white efflorescences, which so frequently disfigure walls laid up in mortars of natural cement, are of various composition, mainly carbonate of potash or soda; are generally favored by dampness; but may be readily removed by scraping.

In the fabrication of mortars for either masonry or concrete, at all important works in this country, the Portland and the Rosendale class of cements are almost exclusively depended upon. We will therefore confine the further treatment of our subject to such mortars and concretes.

It will be borne in mind that all that relates to the materials, composition, durability, etc., of mortars, must of course be of primary importance to the concretes into which they enter.

The use of common lime in conjunction with the cements operates to increase the bulk of mortar, so that, for equal volumes with large doses of sand, the mixture containing lime would be less porous, possess greater proportionate strength, and require a smaller proportion of the more costly cement. Engineers differ as to the ultimate economy of this as a general practice. The water used in mortars should always be clear and fresh—free from vegetable matter or clay in suspension.

To be most suitable for mortar the sand must be clean, hard and sharp, the particles not of too uniform size, nor withal too fine. These conditions are best answered by the silicious sands of the sea shore or river bed. Good sand is also found in banks or pits distant from the shore. Sand from the former sources is more likely to be well washed, though deficient in sharpness, while pit sand may be sharper, but injured, more or less, by an admixture of clay or vegetable mould—very dangerous impurities that cannot be too scrupulously guarded against. They may be deteeted by rubbing the sands in the palms of the hands, but with greater certainty by washing in clean water. The obvious advantage of variety in the sizes of particles is, that such sands are more compact, contain a smaller amount of interstices or voids, and hence require less cement to unite them into a mass of almost perfect solidity. A bird-shot uniformity of size may be overcome by a mixture of different sands. This is best accomplished by experimenting with sieves upon small quantities well dried, to find the proportions in which they should be mixed to produce the greatest weight or density. To do this, measure a cubic foot of the coarser sand, well shaken down, and then gradually add and stir in the next finer grade as long as no increase of volume occurs when shaken down. The proper proportion of the finer sand per cubic foot of the mixture is thus determined, and the quantity that this mixture will take of a still finer grade may then be similarly found.

One of the most satisfactory means of arriving at the value of a sand, or a mixture of sands, with a given cement, is to make small test blocks of the mortar and compare their behavior and strength with those of the corresponding standard mixtures.

As more or less misapprehension as to the actual effect of moisture upon the bulk of sand is always to be found, it may not be amiss in this connection, to give the following from General Gillmore:

One cubic foot of mixed silicious sand,
damp and not compacted, weighed..... 87 lbs.;
damp and compacted, " ..... 97 lbs.;
dried in oven and not compacted, weighed.. 97½ lbs.;
dried in oven and compacted, " ..105½ lbs.;
compacted and afterwards dampened " ..112¾ lbs.;

Mortars made of pure or *neat* cement, with a proper quantity of water, always attain a greater hardness and strength than if mixed with sand. Whether with or without sand, a deficiency of water results in imperfect chemical action, while a surplus renders the hardened mortar porous from the final evaporation of the uncombined water. Experience is the only reliable guide in determinlng the proper measure of water, as it varies with the nature of the work, and the quantity and moisture of other ingredients. By far the strongest mortars of either Portland or Rosendale cements, with or without sand, result from mixtures in a state of incoherent dampness, but it is not always practicable to so work them.

The weakening effect of sand in mortars is not in proportion to its quantity, within reasonable limits, and it is therefore so far an economical substitute for cement. Sand is an adulteration, limited by the strength and density required, a remark equally applicable to concretes, which we shall consider presently.

The best proportions by volume of any given sand may be ascertained by measuring the quantity of water that a compact measure of it, in an ordinary state of humidity, will contain without increase of bulk. Such quantity of water shows what bulk of cement paste is required to make with the sand a solid mass. The possibilities of slight shrinkage and especially of imperfect manipulation, however, render it generally advisable to increase this amount about one-half. A common dose of coarse silicious sand in ordinary work is, by volume, 2 to 2½ parts for Rosendale, and 3 to 4 parts for Portland cement. An inordinate addition of sand naturally causes porosity, which may be thus extended to the final ruin of the mortar.

It is probable that, with silicious sand, a slight superficial coat of silicate of lime is formed on its particles.

Masons dislike to use Portland cement mortar on account of its deficiency in that adhesive consistency peculiar to mortars of lime or natural cement, which requires it to be handled more carefully on the trowel.

Warmth considerably accelerates the hardening of hydraulic mortars; it is therefore necessary to conduct tests of quickness at a uniform temperature, say 60°, in order to arrive at fair comparisons.

Mortars never fully recover from the effects of jarring or otherwise disturbing the process of crystallization, and their ultimate strength may in this way be very seriously impaired.

In order to guard against the many chances for an accidental or intentional supply of inferior or damaged cement, a perfect system of tests should be instituted at all important works, and carefully applied to every new lot of cement received and also to any that may have been long on hand. Judgment must be the guide as to how many barrels shall be tested in any one lot, to the end that the consumer may be satisfied concerning its precise quality. Such tests may be conducted at a comparatively very small expense by an ordinary, if faithful, laborer, provided with the proper apparatus and instructed in a simple routine. A quite complete series of tests consists, in observing, first, the behavior of cement while hardening under water—as to the time occupied in setting,—the hardness attained, and whether it swells or cracks (indicating an excess of quicklime); secondly, its tensile and crushing strength per square inch; and, thirdly, when thoroughly set, its resistance to the weather.

A successful resistance of the first test is an indication that it will fairly stand the third. The tensile strength is generally more easily and fairly ascertained than the resistance to crushing, but the latter more desirable quality may be approximately estimated from the former. It is therefore usual to rely upon only two tests conducted in the following manner:—

The neat cement, or mixtures with sand, are made into very stiff mortar and at once pressed into moulds of two forms, preferably of brass or galvanized iron.

(*To be continued.*)

STEAM ON STREET RAILWAYS.

It is now more than a score of years since street railways were first put in operation in our principal cities. In that time we have seen little change in their construction, equipment and method of maintenance. The cars are, in many cases, somewhat handsomer than at first, but the means of locomotion is still by horse power. Dummy engines have occasionally been placed on suburban lines, where the route was long and removed from crowded thoroughfares, but they have not increased materially in numbers until quite recently, having generally been laid aside after a short trial. The steam engine is much superior to the horse for the purpose of drawing a car, can be easily controlled for starting and stopping, even to the extent of speedily arresting the motion by reversal of the engine as an auxiliary to brake power, can handle a greater load without taking up more street space, can take the place of numbers of horses, requires no food and extra attendance when not at work, and has a much longer life with decent care. We must therefore search for some reason why steam has not been generally introduced on street railways.

The construction of small steam engines of various powers has become wide-spread, and there are many very satisfactory and economical types in use. The firm which shall manufacture and successfully introduce small motors for street cars will do a handsome stroke of business. The field for their occupation is immense. The engine should be simple in detail, strong in its parts, not likely to get out of order with decent care from a driver of moderate ability, quiet in operation and reasonably economical of fuel. The only objection to their employment appears to be the fear that they will frighten horses. Any inconvenience from this source, is, at the most, temporary. The horses of a city will soon become used to the sight of steam cars on the public streets, as they have already, in many instances, become used to the locomotive. And they will be broken to the former the more readily as there will be none of that roar of the train and cough of the exhaust which accompanies the latter.

The evidence all goes to show that this trouble has been much exaggerated. The *Railway Age*, in an article on this subject, states that the Citizens' Passenger Railway Company, of Baltimore, have been, for some months, testing a dummy on some of the busiest streets of that city, and are so well convinced of its economy and general advantages that they have applied to the City Council for permission to operate steam motors on all of their cars. The testimony of a majority of the business men is that horses will soon cease to be annoyed by the engines, if these are generally introduced, and is decidedly in favor of the change. Those horses which were frightened at first, now do not mind them. It is further testified that the dummy can be handled more readily, can be backed with ease in a crowded street, and can keep out of the way with greater facility than can a horse car.

No more men would be required on a car, although the engine driver should possess more intelligence than is absolutely requisite in the present driver, and might command higher wages. The force of stable men would disappear, being replaced by a few cleaners and other men necessary to an engine house. But little modification in the repair shops of the company would be called for.

We saw a dummy in use on Market street, in Philadelphia, last summer, at the time of the great crowds of the Centennial Exhibition, and its operation was attended with no difficulty. That Passenger Railway Company are so well satisfied with the results of their experiment that they have procured several additional steam cars, of the Ransom pattern, and are now about to put them on their lines. They have some of different designs, though how they differ we have not been informed, and will finally adopt that type which works most satisfactorily.

As facts are more convincing than any theory, we give the following comparative statement of cost of the two systems of steam and horse power in Philadelphia. The Market street line has as steep grades as are to be found in most cities.

Feed and care of eight horses one week	$24.00
For pay of driver at $2 per day for seven days	14.00
Total cost of horse car in one week	$38.00
Fuel for one week, 1¼ tons	$8.75
Salary of engineer one week (say at)	18.00
Total cost of steam car in one week	$26.75

After this problem has been worked out, to the satisfactory substitution of steam for horse power, the question how to warm a street car so that it shall be reasonably comfortable in cold weather is answered without further trouble. The boiler in one end of the car will readily furnish steam or hot water, if it is not rather thought expedient to use exhaust steam for heating purposes. The latter method would not answer where a car was likely to remain standing for any length of time at a terminus. The subject of heating these cars has been lately discussed in the New York papers, interest having revived in this matter by reason of the cold of December and January. Several inventors have come forward with expedients, such as hot-water receptacles under the car, which should be replenished at the ends of the route or at convenient intervals, balls of cast iron or a mass of the same material heated very hot and placed in a similar receptacle, etc.

Strange to say there have been found physicians who argued that heating would be unhealthy, in that warm air would tend to promote the contraction of contagious diseases in the crowded cars. So that the Board of Aldermen of the city of New York finally settled down to the resolution "to direct the Board of Health to compel railroad companies to keep, while *en route*, the front doors of their cars constantly closed in cold or stormy weather, and that clean straw be provided for the floor of every car in such quantities and seasons as the Board might direct," a most impotent conclusion of a well advised attempt to ameliorate the present chilly condition of a horse car in winter. Which is the healthier, to be cooped up in a car with from twenty to forty others, when every door and aperature is kept closed, in order that the animal warmth of the crowd may have some effect on the interior air, this air being respired over and over again and polluted with the various emanations from the occupants, till every one becomes dull and weakened in vital force; or to occupy a car so warmed that air must circulate and pass out to enable warm air to come in?

When steam cars are once successfully introduced upon street railways, we shall look for the adoption next of traction engines for handling the heavy loads, which are now conveyed from foundries and iron working shops by the aid of large teams of horses, taking up much space and seriously interfering with public convenience. These engines have been used in considerable number in some of the cities of England and Scotland but we believe the only shape in which steam appears in the streets of our American cities, except as previously noted, is in driving the heavy road rollers, so effective in consolidating the roadway.

EGAN, the architect of the Court House has claims of $26,000 for extra plans, and about $5,000 more for superintendence.

WORK for the season has been commenced on the New Court House. It will require $450,000 to enable contractors to finish the work satisfactorily, a sum which in the present financial condition of Chicago and Cook County will not very likely be forthcoming.

BLUE GLASS, to judge from the papers, is to have its healing and health promoting qualities very thoroughly tried by the public. It has become quite the fashion. It seems a little curious that the same blue rays will according to Pleasanton's book, promote the growth of animals and plants which are desirable and of use to man, while they are destructive to weeds and vermin-flies and such petty annoyances. His deductions from his experiments do not appear to be logical.

THE American Society of Civil Engineers held their second meeting of the month at the rooms of the Society, No. 4, E. 23d St., New York city, on the evening of the 21st of February.

The evening was entirely devoted to the subject of the Ashtabula Bridge (which is gaining in interest as the facts concerning its construction are eliminated, and the discussion upon the merits of various systems of bridge building progresses); a paper giving the results of his observations, by Mr. Chas. McDonald, was read, and a general discussion by several members was participated in, after which the meeting adjourned.

(Our correspondent has sent us an abstract of the paper and of the discussion, together with a diagram, but as we expect that every reader of the NEWS, who takes any interest in the subject of the Ashtabula Bridge, intends to possess a copy of the forthcoming book containing the complete report of the coroner's jury, which is advertised by us in another column, so we do not expect to publish much, if anything more upon the subject.—[ED.

WE need hardly call attention to the increasing amount of contractors' intelligence that we are now publishing, nor of the importance of this information as furnishing a basis for future bidding from a comparison of the figures given. We are very much obliged to the parties who have so kindly sent us the information in answer to our request, and we hope to be able, as the season advances, to make this department of our journal one of very great value to a large class of its readers.

AT the meeting of the American Institute of Mining Engineers, on the evening of the 27th ult,, in the rooms of the American Society of Civil Engineers, in New York, over forty new members were elected, from all parts of the United States and Europe, swelling the membership to more than six hundred. The programme was announced for the rest of the convention, which includes a visit to the new Bergen tunnel of the Delaware, Lackawanna & Western Railroad.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 73d regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on Tuesday, the 6th of March, beginning at 4 P. M.

The chair was taken by the President, Mr. E. S. Chesbrough.

Mr. L. P. Morehouse, the Secretary, read the minutes of the previous meeting, which were approved, after which the Club proceeded to elect Mr. Charles Sooysmith, proposed some three months back, but whose absence in Europe delayed his election, the necessary papers having been sent to him and returned.

The Secretary reported the receipt of the "Annual Report of the City of Allegheny," Mr. Charles Davis, City Engineer, and the "Annual Report" of the Chief of Engineers, U. S. A.

At the conclusion of some remarks by the President, Mr. L. Y. Schermerhorn proceeded to read his paper on the "Improvement of Eagle Harbor," Lake Superior.*

C. W. Durham, C. E., presented a petition, for the signature of members, praying Congress to appropriat the sum of $50,000 to establish a colony near the scene of the latest Arctic researches, in order to complete the same to the fullest extent possible.

A vote of thanks was unanimously tendered to Mr. Schermerhorn for his interesting paper, and the meeting adjourned for informal conversation.

Written for "Engineering News."

DESCRIPTION OF THE WATER WORKS AT BANGOR, MAINE.

BY L. H. EATON, C. E.,
Engineer Bangor Water Board.

These works are situated one and one-half miles from the post-office, in Bangor, and are upon the plan of direct force, known as the Holly system. There are four piston pumps, of twelve inches diameter of cylinder and twenty-seven inches stroke, mounted at the four corners of the base of a heavy cast-iron frame and connected to a crank shaft above. The shaft is carried in boxes on the upper arched portions of the frame, and the two pumps on each side transverse to the shaft are connected to the same crank pin, the piston rods making an angle of 45° with the vertical; the two crank pins, at opposite ends of the shaft are so disposed that the pumps take suction and discharge at eight equidistant points for each revolution, securing a uniform flow into the main. Either pump may be disconnected so that one or more may be run at any one time. These are supplemented by an elliptical rotary pump of the capacity of sixteen gallons per revolution; the whole set

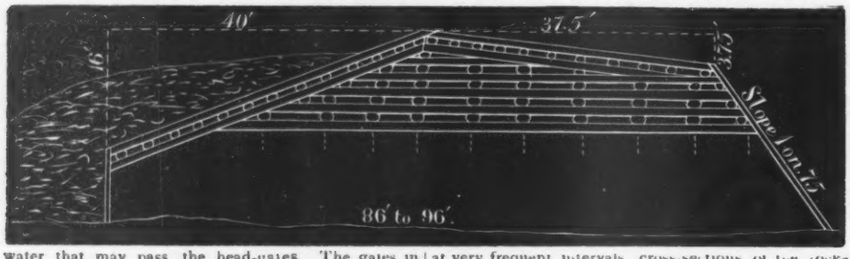
* This paper is printed in full on page 65.

is capable of easily supplying five million gallons in twenty-four hours.

The pumps are driven by three American Turbine wheels, made by Stout, Mills & Temple, Dayton, Ohio., eighty-four inches in diameter, working under a varying head of from five to fourteen feet, according to the rise and fall of the tide. Thus far it has only been found necessary to use two of these wheels at once, and then with a gateage of from one-fourth to one-half their capacity, accoading to the tide, even in case of the largest fire experienced since the construction of the works. In addition the works contain a compound steam engine, built by the Holly Manufacturing Company, the high pressure cylinder being fourteen inches diameter with a piston travel of twenty-four inches, and the low-pressure cylinder being twenty-one inches diameter and thirty inches stroke. They may both be worked at high pressure when necessary.

This engine is supplied by steam by two horizontal tubular boilers of five feet diameter and fifteen feet long, each having fifty-four three-inch tubes, and set in a room adjoining the engine and pump room, with a smoke-stack outside, seventy feet high. The boiler-room is thirty-nine by forty feet, the pump and engine-room is fifty feet square, and the wheel-house, adjoining the pump-room, on the end opposite the boiler-house, is thirty-nine by forty-four feet over the machinery floor, of which a tenement is finished off for the residence of the engineer.

Water is received into the wheel-pit from the head-race through two arches of 190 square feet area, causing the current into the wheels to be very slight, and passes from the pit into the tail race through arches of 150 feet area. The current from the wheels is very much more rapid as the tail race descends rapidly. These arches are so arranged that the water will at all times cover the entire intrados, thus excluding the cold air and preventing ice forming in the wheel-room or flume. The outer or coarse rack is so arranged that it is entirely below the surface of the water in the pond, thus allowing drifting substances to pass over the dam. The fine rack is so situated that anything that passes the outer rack and the head gates draws by it and passes through the waste way of the flume into the river below; this waste way is intended also to provide for any excess of water that may pass the head-gates. The gates in the wheel cases are controlled by one of Holly's automatic governors, which, by means of belts and gearing, opens them when the pressure is diminishing in the pipes, and shuts them when the pressure is increasing, a very ingenious piece of mechanism and admirable in its operation.



The pressure in the pipes is governed by a safety valve leading from the force main, which valve may be weighted to whatever pressure may be needed. For instance, the domestic pressure is one hundred and ten pounds; if fire pressure is needed on high service, say two hundred and thirty feet above the works (our highest service), the engineer has simply to weight the safety valve to its proper requirement and, setting the indicator of the governor at the required pressure, it at once runs up. If the movement be too slow to meet the need for an immediately increased supply of water, it can be expedited by the engineer turning the governor by hand.

Communication is had with the works by means of telegraphic gongs, that the engineer may be informed of any want of increased quantity of water for fire or other purposes.

The water flows from the flume to the filter through a revolving screen of copper wire netting, which catches and passes off into the wheel-pit any saw dust or other small substances that may be held in the water. The filter is of two chambers, each twelve and one-half feet wide by one hundred and fifty feet long. From these the water passes into a filtered water chamber, from which the suction pipes take it to the pumps. The filter bed is composed of brick, gravel and sand, and yields sufficient water to supply the demand of the largest fires. The buildings are heated by steam; therefore, as our boiler is always fired up in winter, if the wheels become clogged with anchor ice, or an accident happens to them, immediate resort may be had to steam power.

The system of mains comprises twenty-one and one-half miles of pipe,—cast-iron, tar coated;—the force main is sixteen inches in diameter, and extends from the works one mile into the city, at which point it is reduced to twelve inches, having, before reaching that point, been relieved by numerous secondary mains. The distance from the works to the end of the most remote pipe is about two and three-fourths miles. There have been set one hundred and forty-six hydrants, principally of the Holly pattern,—a few Matthews hydrants are in use.

The dam for the water power is at a locality known as Treat's Falls, one and one-half miles from the post office; these falls were simply rapids with a natural descent of about twenty-two inches. The tide has here a mean rise and fall of about twelve feet. The crest of the dam is eight feet above mean high tide, and has an overfall nine hundred feet in length between abutments; the river bottom is of slate ledge, irregular in its contours, with a trend crossing the direction of flow of the river at an angle of about forty-five degrees. The dam is of crib work filled with stone. Into the irregularities of the ledge, timbers were fitted until the work was brought up to a height to admit of the regular crib work being fitted upon it, the entire structure was thoroughly bolted together with seven-eighths iron bolts, and solidly packed with rubble, common field stone and stone from the river shores; it was then covered with six-inch hemlock plank, the toe filled and covered to a depth of from eight to ten feet with gravel and stone. The accompanying sketch will give the form of the dam, and and an idea of its structure.

The dam was commenced at each end and extended into the river by placing tier after tier of logs from the bottom up, until the water at low tide was too deep to permit men to place the logs. The remaining gap, of some three hundred feet, was then carefully sounded out at very frequent intervals, cross-sections of the rock-bottom thus obtained and cribs were built to fit the same. These cribs were as long as the breadth of the dam, some fifteen or twenty feet wide, and came a little above low water level when sunk. They were successively floated to place at high tide, moored in position, adjoining the portion already partly built, and sunk by loading with stone. Jogs or shoulders on the faces in contact kept the sinking crib in line, while strong tackle drew it firmly against the end of the dam. On the receding of the tide it was filled completely with stone. The entire gap was thus filled with cribs, which came above the low water line on the lower side of the dam. A coffer dam or temporary construction was formed, to stop the flow of water over this portion and cause it to run over the completed part. As the cribs were built hemlock posts 12" × 14", set eight feet from center to center, and about six feet from the toe or upstream line of base of the dam, were framed in vertically, in some cases being permanently fastened, and in others being fitted into deep sockets and then removed, to be put in when the dam was so far finished as to require the coffer to be planked up. This space was left to permit the passage of rafts and logs until the water could be turned through the sluice way. The posts were then put in place, the planking put on the upper side, and the coffer was thus completed. This was done under difficulties consequent upon a heavy rise in the river, but was successfully accomplished. The space thus laid bare was built up with logs, care being taken to bond the whole well together, and the stone and planking was added. After the dam was completed, the coffer planks were removed and the posts sawed off. The abutments, of granite masonry, are ten feet six inches above the crest of the dam, with provision, in case of an extraordinary rise in the river, for flash boards upon the abutments and wings of two or three feet more. The expense of the dam, abutments and wing walls has been about one hundred and fifty thousand dollars, and it is considered one of the most substantial dams in the country.

There is, at the lowest stage of the river, in the summer drought, a nominal horse power of forty-five hundred at mean high tide and at low tide, of eighty-seven hundred; this stage usually lasts but about six weeks in the summer, and occurs in the winter for a shorter period, ordinarily about four weeks. This would give at the respective stages of the tide an effective horse power of about thirty-six hundred and seven thousand. The larger head has a duration of from one-third ebb to two thirds flood, or for a space of about eight hours out of the twelve. Only about forty-five horse power is used in driving the pumps for ordinary domestic service. The dam is so built that it can be readily increased in height when greater power is needed to supply factories and mills.

The line of the E. & N. A. Railway passes in the immediate vicinity of the dam and will afford facilities for transportation of freight, without damage. Boats and sailing vessels of eight or ten feet draft can also come to the works to discharge and receive freight, while twenty or more feet of water is found at the railroad wharves two miles below.

A fishway is being constructed upon the easterly end of the dam adjoining the abutment after plans furnished by C. G. Atkins, Esq., engineer of the U. S. Fishing commission, at an expense of about six thousand dollars. It has the general form of a spiral stair case, and will be ready for service in season for the spring run of fish.

GENERAL PROPERTIES—DETERMINATION OF DIMENSIONS.

The method of determination of the proper dimensions of the various component parts of constructions of iron and steel has, until recently, been as follows: Having determined by the *statical* calculation the greatest stress, $max\ B$, which can ever act in the part in question, we divide this stress by the assumed allowable stress, b per unit of area, and thus obtain the required area of cross-section

$$F = \frac{max\ B}{b} \quad (1)$$

which the piece in question must have in order to safely resist the given stress.

In general the value of b is taken invariable, no matter whether the stress is caused by constant or *dead* load, or whether the load and, therefore, corresponding stress, undergoes sudden changes, as in the case of bridges, rails, axles, etc. In Prussia, for example, the value of b for iron is almost universally assumed at 730 kil. per square centimetre (10,400 lbs. per sq. inch), and this value is assumed indifferently for tension, compression, and shear.*

Gerber, in the calculation of the Mainz bridge, was the first to depart from the above practice. He assumed for each member of the construction a different value of b, taking it less as the proportion of the stress due to moving load to that due to the dead load increased.

When a member is submitted also to alternate tension and compression, formula (1) was still considered as holding good, the *absolute* greatest value being taken for $max\ B$. The American practice has, in such case, been a more rational one. According to it, if $max\ B$ and $max\ B'$ are the greatest strains of opposite character, then

$$F = \frac{max\ B + max\ B'}{b} \quad (2)$$

where the usual invariable value of b, as above, is however assumed. Numberless axle failures, boiler explosions, bridge failures, etc., admonish those interested to search after the causes of these occurrences. Such occurrences are the more noticeable, inasmuch as a coefficient of safety is always used which, it would appear,

*These remarks do not apply to present American practice.—Different values of b are taken for tension, compression, etc., though constant for each.

ought to exclude every danger. The question, therefore, presses hard upon us, whether our iron bridges in general really possess the durability assigned to them. We have, as yet, no experience in this direction to appeal to, since the application of iron in bridge construction reaches back hardly a hundred years. In the year 1874 the society "Deutscher Architecten-und Ingenieurvereine" determined to seek, by systematic and similar observations, a solution "in order that those engineers engaged in the maintenance of iron structures may not be confronted with catastrophies."

The foregoing is an extract from a forthcoming translation of Prof. Jacob J. Weyrauch's book, on "Strength, Dimensions and Calculation of Iron and Steel," with reference to the latest experiments, by Prof. A. Jay DuBois, author of "Graphical Statics."

A BILL has been introduced into the New York Legislative Assembly, to provide a "State Board of Health," in reference to which *The Sanitarian* presents the following statistics and comments:—

The local and public causes of destructive diseases which strike down the most valued classes of inhabitants, as well as the poor and those who are least protected, because unnoticed, are every year endangering the loss of lives which the State should protect and save by the practical application of sanitary knowledge for the prevention of such causes of disease and mortality. In the State of Massachusetts the eminent financier and economist, Hon. Mr. Plunkett, stated, after a few years' operations of the State Board of Health, that in single large villages, the saving of life and health by agencies exerted by that Board had been worth more in cash than the entire annual expenses of the Board.

During the census year of 1870, New York, with a population of 4,382,759, had a recorded mortality of 69,095; and that number is, with good reason, believed to be considerably less than the actual mortality, because this State has no system of general registration of deaths. In the total record of mortality, 17,596 deaths (25.46 per cent.) were caused by zymotic diseases, which are the most preventable of disorders, and comprehending 6,930 deaths from diarrhœal diseases; 3,403 from scarlet fever; 2,029 from typhoid fever, and 864 from diphtheria, a disease which has so increased in prevalence since 1870, as, in 1875, to have destroyed not less than 4,000 lives.

Of the other causes of mortality—namely, the remaining three-fourths—11,598 died of consumption, and 8,158 from other diseases of the respiratory organs—and these diseases are largely dependent upon preventable causes, as well as the zymotic diseases. 2,664 deaths resulted from violence: burns, scalds, drowning, suffocation, explosions, "accidents," etc., etc., in the main due to the want of intelligently directed public measures for their prevention. Taking all together, of the total number 69,095 deaths from all causes, 53,902 from the eight categories above given are in large measure preventable by well recognized sanitary measures, such as no less than twelve States of the Union have established during the past few years.

Again, that this waste of life may be made still more apparent: of the total number of deaths, 69,095, for the year, 31,602 were of infants and children under 15 years of age; and of these 27,071 were under five years of age. That the loss in pecuniary value to the State from these 31,602 premature deaths may be duly appreciated, it is only necessary to remark that the cost of their sustenance from birth to death was a total loss—they died without living long enough to render any material return for the cost, and to this is to be added the expense of sickness and burial. By assuming that the average lifetime of the whole 31,602 infants and children was only five years, and that the cost of this five years' sustenance, sickness and burial was only $200 each, we have in this item a dead loss from premature deaths of children, $6,320,400.

Again, of the deaths enumerated for the year under zymotic diseases, 2,029 were caused by typhoid fever, a disease which kills most of its victims in the prime of life, at a time when the individual is of the most value to his family and the State. The average value of lives taken by typhoid fever (of both sexes), at a moderate estimate, is not less than $1,500 each. The loss to the people from this cause, therefore, amounts to over $3,000,000 annually—for there is no question that considerably over 2,000 deaths from typhoid fever have occurred annually in the State for many years, and of all the diseases enumerated, typhoid fever is well known to be entirely preventable by sanitary measures.

The more closely unsanitary conditions are examined, the more extensive do their ramifications appear, and in whatever degree the duration of life is diminished, in the same degree so much productive power is lost. And every community is poor and powerless in the inverse ratio to its standard average duration of life and health. Every death under the age of twelve years at least carries with it a positive loss to the community in which the individual has lived, because, previous to that age, sustenance involves a direct outlay, and if the life of the individual is preserved, a productive member of society is added and remuneration rendered. And as regards adults—if the probabilities of life in any community are so low as to give the average adult age at death below the ripe maturity of life, the proportion of widowhood and orphanage is increased, and the productive members of society are proportionately burdened, and thus it is that burdens are created and costs entailed upon the industrious survivors of every community in direct ratio with a high mortality.

[*Written for Engineering News.*]

CEMENTS AND CONCRETE.

BY BERNARD R. GREEN, C. E., PORTLAND, ME.

(*Continued from page 58.*)

One mould is a ring of about 1½ inches diameter and ½ inch width, immersed in a shallow trough of water as soon as filled, where are observed the tendency of the mortar to crack and the progress of hardening while setting. The latter action is noted by frequent applications of the end of a loaded blunt needle, called a testing wire, usually 1-12th inch in diameter, and weighing ¼ pound: but this test is less needed with Portland than with Rosendale cement. The other mould forms a flat I shaped brick, the standard cross-section of the neck being 1½ inches square, equal to 2¼ square inches. The testing apparatus consists of a scale beam provided at the short arm with a pair of clips fitted for clasping the heads of the brick. [The reader is referred to the treatise on Sanitary Engineering, now current in ENGINEERING NEWS, for a brief description of and drawing (Plate V, Figs. 16 and 17) of this apparatus; tables of strength of cements, etc.; and the application of concrete in sewer work.] After this test brick has arrived at the desired age, commonly seven days,—one in air, and six in water,—it is placed in the clips and exposed to a steadily increasing tensile strain, applied without shock or jar, by means of a sliding poise, or a spring balance attached to the extremity of the beam, and carrying a pan into which sand, shot, or water may be gently poured.

The test of strength with doses of sand generally obviates the necessity for tests of fineness and weight of the dry cement powder.

Resistance to frost may be rapidly tested by repeated exposures to freezing mixtures.

The following notes and tables of the strength of cements and mortars are, with the exception of those marked *, compiled from the experiments of General Gillmore, and of Mr. Grant, of London. Unless otherwise specified the test pieces were made of stiff mortar pressed firmly into the moulds by hand. Proportions are given by volume loosely measured.

TENSILE STENGTH.

Test pieces seven days old—first day in air, and balance in water—unless otherwise stated.

English Portland, neat, weighing 103 to 126 lbs. per U. S. bushel, sustained 239 to 406 lbs. per sq. inch.

Standard English Portland, neat, weighs 106 to 110 lbs. per bushel; sustains from 178 to 222 lbs. per sq. inch and requires 42 to 44 per cent. of its volume of water, to convert it into paste of the consistency of masons mortar, but more if the cement be fresh as it may then contain some quick lime.

English Portland.			Boulogne Portland.		
Cement.	Sand.	lbs. per sq. in.	Cement.	Sand.	lbs. per sq. in.
1	0.5	202*		0.42	232
1	1.0	177*	1	0.85	197
1	2.0	96*	1	1.13	139
1	3.0	68*	1	1.70	109
			1	5.00	35

Neat English Portland, at age of one year, about 500 lbs. per sq. inch.*

Rosendale Cement.

Neat	72 lbs. per sq. inch.
Cement 1, sand 0.6	51 " "
Cement 1, sand 1.8	33 " "
Cement 1, sand 2.4	22 " "

On one occasion neat cement varied in five lots from 18 to 65 lbs., and averaged 47 lbs. per sq. inch.

At the age of fifteen months, kept in a damp place but never under water:—Neat, 154 lbs.; with sand 1,—132 lbs.; with sand 3,—63 lbs. per sq. inch.

	lbs. per sq. in.
Neat, rammed, 25 days old in damp place	218*
" 1 day in air, 7 days in water	126*
" 8 days in air	197*
" 8 days in air, (single test)	227*

TRANSVERSE STRENGTH.

Test pieces formed by vertical moulds into rectangular bars of 2 × 2 × 8 inches; allowed to set one day in air under a pressure of 32 lbs. per sq. inch; afterwards immersed in salt water for 319 days; and then broken in a horizontal position upon supports four inches apart by a weight at the middle, gave the following results:

	Rosendale.	*English Portland.*
Neat	635 to 871 lbs.	1536 lbs.
Cement 1, sand 1	620 lbs.	1263 lbs.
Cement 1, sand 2	516 lbs.	950 lbs.

A thin paste of neat Rosendale, similarly treated, sustained from 613 to 692 lbs.

CRUSHING STRENGTH.

Blocks, 3½ × 5½ × 3 inches, seven days old,—first day in air, remainder in water. Area of compression, 19¼ sq. inches. Results in lbs. per square inch.

		Rammed.	*Not rammed.*
Boulogne Portland.	Neat	2,847.	2,597.
	Cement 1, sand 1.70	2,804.	1,038.
	" 1, " 2.55	1,454.	976.
	" 1, " 3.40	931.	747.
	" 1, " 5.00	519.	259.
Rosendale.	Neat, 1	727.3	104.7
	" 1, sand 1.20	310.9	52.4
	" 1, " 1.80	116.4	61.7
	" 1, " 2.35	156.0	
	" 1, " 3.50	52.0	

English Portland Cement. Prisms, 2¼ × 4¼ × 9 inches, on end. Results in lbs. per sq. inch.

Cement.	Sand.	Age, 3 months.	Age, 6 months.	Age, 9 months.
1	0	5806	5388	5974
1	1	2518	3455	4598
1	2	1991	2752	3031
1	3	1406	2167	2401
1	4	1347	1816	2226
1	5	933	1523	1698

The ratio of the crushing to the tensile strength of Portland cement increases rapidly with the addition of sand.

It is thought that the results of the above experiments bear with undue severity on the Rosendale cements. Although these cements frequently show discrepancies in strength there is doubtless little difficulty in finding grades that are much superior to the above; we think such will resist, neat, a tensile strain of not less than 75 lbs. per sq. inch when seven days old. This natural liability to imperfection plainly indicates the necessity of careful testing.

Portland cement, on the contrary, is easily made and preserved of the standard quality, which it has very generally been found to possess in the market.

Curves representing the progress of induration have a parabolic form which is much more regular and apparent for Portland than for Rosendale cements.

General Gillmore experimented upon the adhesion of Rosendale cement to bricks by cementing them together in pairs face to face (flat), and finally separating them by a direct pull. With neat cement, at the age of 320 days, the bricks generally gave way, but with mixtures of sand the fracture occurred in the joint. The following tests where similarly conducted, except that the age was but twenty-nine days, and the pieces were wetted on alternate days.

	Bricks.	*Fine cut Granite.*
Neat cement	30.8 lbs. per sq. in.	27.5 lbs. per sq. in.
Cement 1, sand 1	15.7 " " "	20.8 " " "
" 1, " 2	12.3 " " "	12.6 " " "
" 1, " 3	6.8 " " "	9.2 " " "
" 1, " 4	5.2 " " "	7.9 " " "

It is desirable that the strength and durability of mortar should be quite equal to those of the other materials in a given piece of masonry or concrete, being exposed alike to causes of disintegration. The figures we have given show that the natural cements are not to be relied on, always, as to strength, while Portland cement closely approximates, in this respect as in others, to the better building stones. In removing heavy courses of granite headers and stretchers cut and laid in Rosendale cement in the best manner the writer has, however, seen the beds of the stones partially scaled off, by the adhesion of the mortar, to such an extent as to require re-cutting. This result was doubtless favored by the manner of prying up the stones, and the excellence of the pointing.

Frost gradually disintegrates the surface of exposed Rosendale cement work, though some specimens have been observed to resist it well. Mortar of good Portland cement, after several years exposure to an annual range of temperature from —10° to + 90°, shows not the slightest change of surface.

The tensile strength of Portland cement, mixed to a stiff paste with or without sand, seven days old, is from four to six times greater than that of Rosendale cement similarly treated; but when both are mixed with much water the former may be twenty times stronger than the latter.

CONCRETE.

In recent years the advancement made towards the perfection and cheap production of cements and machinery, has been such that old mixtures and methods will seldom be resorted to in making concrete.

Good concretes must contain mixed sizes of aggregates, disposed, as are the sands in good mortars, in such manner as to produce maximum compactness, and thus require but a minimum of the more costly cementing element. The materials depended upon are enumerated in the general description of concrete heretofore given. Silicious sand hard pebbles, and any hard variety of stone (granite, limestone, etc.), broken to a suitable size, are best; these can generally be obtained in quantities bearing some desirable proportion to each other, and are usually employed in important work, but sometimes the dearth of coarse ballast necessitates the use of sands alone. All these materials should be perfectly clean, otherwise they should be washed in running water, the surf of the sea shore, or by mechanical means. It may occasionally be more economical to increase the proportion of cement in such cases, if it be done intelligently with proper tests. The presence of clay, vegetable mould or "dirt" of any kind is a potent cause of failure, destroying the binding effect of the cement, and hence the coherency of the mass.

Broken stone should be chosen of irregular fracture, not liable to break into flat spawls, nor to give off much dust; the latter should be screened out. Blake's stone-

breaker is the machine at present generally employed for the reduction of the stone. The sizes of the broken stone should be mixed from 1 to 3 inches diameter, governed by the sizes of the other materials at hand.

It is desirable that all the ballast should be hard enough to resist shattering, or even cracking, in ramming.

When the materials are assembled, the next step is to ascertain the voids or interstitial space in each material, by which the best proportions for mixing are indicated, the calculation of space to be occupied by mortar being finally checked by measuring the voids in the proposed mixture. By experimenting in this way considerable nicety of proportion may be arrived at when desired. As previously explained for sand, the voids are readily found by filling a yard measure with the dry material, well shaken down, and measuring the quantity of water it will then hold. Account should always be made of any large quantity of sand contained in the ballast.

In broken stone, of pieces varying from 1¼ to 3 in. diameter and of all shapes the voids are	.50 per cent.
In pebbles of mixed medium sizes	.28 " "
In coarse sand of nearly even grain	.37 " "
In broken stone 1 part, pebbles 1 part mixed	.31 " "

By good proportions the voids of a mixture may be reduced to 22 or 25 per cent.

In proportioning ingredients regard should always be paid to the rule that the quantity of smaller particles, which go to fill up the voids in the next larger size, should always be in excess by an amount determined by the facilities for thorough incorporation; any greater excess being then a question of economy in each case. The bulk of rammed concrete should always be materially greater than that of the contained coarser ballast.

The state of humidity of both atmosphere and ballast affect the quantity required to produce a desired consistency. Workmen must be watched at this point to prevent the indiscriminate use of sun-dried and rain-soaked materials.

Of the many methods of mixing, but one by hand and two or three by machinery are prominent. The first, now practiced only where the limited extent of work will not warrant the expense of a machine, is best performed by four men with shovels upon a platform about 10 ft. square, thus:—

The intended measure of sand for a batch, say 2 barrels, is spread upon the platform and covered by the dry cement, 1 barrel. The whole is then thoroughly stirred by a skilfull use of the shovels, and formed into a shallow basin, into which is thrown most of the water required for the batch, the balance being added later as needed to facilitate the mixing. The mass is again thoroughly turned and mixed until a homogeneous paste is produced; thinly spread out; evenly strewn with the whole proportion of pebbles, say 4 barrels; turned again; again spread out; the quota of broken stone, say 5 barrels, thrown on; and the mixing completed by a thorough turning and re-turning of the whole mass. This is accomplished by opening successive furrows by shovelfuls, instead of continuously like a plow, from two opposite sides to the middle, and then back again. Two such turnings for each of the three additions of material will ordinarily suffice, occupying in all about 30 minutes. To take advantage of a quick-setting cement this time should be shortened by employing more men upon smaller batches. With slow cements the mixing may be more thorough.

The batch assumed is a common one for an ordinary quality of concrete with Rosendale cement, upon large works, and will make rather more than a cubic yard, rammed, depending upon the shapes and sizes of the ballast.

On works of sufficient magnitude the employment of machinery, in the various steps of preparing, manipulating and transporting the materials, saves time and cement, and renders a thorough trituration and incorporation of elements certain and uniform in every batch. Mixing by hand is exceedingly laborious and consequently liable to be imperfect towards the close of a day's work, while the tireless machine still performs its certain round. Existing machinery not only turns out concrete much faster than will a practicable amount of hand labor, but it makes possible, by most intimate and homogeneous mixture, the use of the minimum quantity of cement necessary to completely coat each particle of the aggregates. Mixing machines have been in use for many years in Europe and lately in this country. An early design that served its purpose well, consisted of an iron cylinder—the shell of an old steam boiler, for example—open at both ends and rotating slowly on an axis inclined a few degrees to the horizon. The materials in suitable proportion were constantly fed into the upper end, to fall in due time, well mixed, from the lower end. Of the various devices that have been tried we will describe but one, which has been adopted quite generally on our government works, and which seems to combine most of the elements of perfection. It consists essentially of a very strong cubical box about four feet square, of iron or wood, through two corners of which runs diagonally a stout shaft, firmly secured to the box by cast iron hubs. The shaft rests in bearings, rigidly supported on standards or otherwise, and carries at one end a pulley, spur, or worm gear, preferably the latter, by which a rotary motion is imparted to the box from a steam engine. The cost of such a mixer is from $200 to $300.

In a corner of the box is a trap door through which it is charged from a platform above, and discharged from below, after the mixing is completed by a suitable number of revolutions. The severest wear, in the interior of this mixer, occurs upon an area, about two feet in diameter, in the middle of each side, and around the trap; these parts should be protected, in a wooden box, by thin sheet iron.

(To be continued.)

CORRESPONDENCE.

KANSAS CITY, MO., *March 5, 1877.*

Editor ENGINEERING NEWS:

SIR.—I have examined my question page 27, No. 4 of ENGINEERING NEWS, and fail to see how "C. R.," page 57 of No. 9, can understand it as ascribing pressure to the escaping gases. It will be readily understood that quantities used in such a question must be merely illustrative, the real ones depending on and changing with every variation of either theoretical or practical data. The change from heat to work is not the question, that is generally understood—is written in books—the loss in question is loss of temperature resulting from this change, the gain hoped for, the utilization of more heat from the escaping gases of combustion for the same purpose. Seeing that the question is entirely misapprehended by "C. R.," and hoping that this may serve to make the point aimed at clearer, and invite attention to a subject which is certainly important, induces me to make this rejoinder. G. W. P.

FORT WAYNE, IND., *March 3, 1877.*

Editor ENGINEERING NEWS:

SIR.—As your correspondent Mr. L. L. Nichols, refers to a communication upon the subject of sewers by Mr. E. C. Clarke, which I have not seen, it may be thought that I should allow him to reply; he might not, however, and as a communication from me upon the same subject was published in the NEWS of January 13th, 1877, I wish to notice briefly Mr. Nichols' letter. I have not the benefit of reference to Mr. Kirkwood's book, having only some written notes, but I recollect that the formula $D = \left\{ \frac{m^2}{1450\ S} \right\}^{\frac{1}{5}}$ was based on half a cubit foot, nearly of rainfall, per second, per acre, reaching the sewers; this half cubit foot, nearly, was also based on certain proportions of a rainfall of one inch per hour, reaching the sewers from the street, the house-tops and the yards, within the hour; and as the factor n representing the acreage is a little more than double the factor m representing the cubic feet thus ascertained, and as both vary in the same proportion, he gives the formulæ

$D = \left\{ \frac{m^2}{1450 \times S} \right\}^{\frac{1}{5}}$ and $D = \left\{ \frac{n^2}{5804\ S} \right\}^{\frac{1}{5}}$ consequently $\left\{ \frac{n^2}{5804 \times S} \right\}^{\frac{1}{5}} = \left\{ \frac{m^2}{1450 \times S} \right\}^{\frac{1}{5}}$

I may add that Prony's formula, as quoted by Mr Kirkwood, gives 17 cubic feet instead of 8.56 as stated by Mr. Nichols: for example, $38.08 \times 2.16' \sqrt{2.16 \times S} = 17$ nearly; and according to the modification of the formula, using the fifth root the acreage is 34; using the sixth root, however, the result in cubic feet is 25 and the acreage 50 nearly. JOHN RYALL, C. C. E.

BOSTON, MASS., *March 5, 1877.*

Editor ENGINEEEING NEWS:

SIR.—It may not be uninteresting to you to know that large beds of chalk have been discovered in Kansas within two or three years. They are located about three hundred miles west of Kansas City. It is soft and fine grained, white or slightly yellow, from the presence of oxide of iron. So far as it has been examined, there are no traces of the Rhizopod shells which compose so great a part of the European chalk. Following is an analysis of two samples. No. 1 was pure white. No. 2 was yellowish, and a sample of the poorest:

	No. 1.	No. 2.
Moisture	.34	.58
Insoluble in acids (silica, lime, and alumina)	.69	11.40
Alumina (little oxide of iron)	.43	.97
Ferrous carbonate	.14	2.83
Calcium carbonate	98.47	84.19
	100.07	99.97

The special importance of this is in its applicability to the manufacture of Portland cement. With this chalk, and the clay found also in Kansas, a Portland cement can be manufactured equal in quality to the imported, at a cost of ten to twenty per cent. less. There is a good chance for some man's surplus capital in commencing its manufacture.

I have attended one or two meetings of the Boston Society of Civil Engineers, which were very interesting. The last one was devoted mostly to a discussion of the Ashtabula bridge. The City Engineer of Newport gave a short description of sewerage works established by him at Lenox. An article from him would be interesting. The sewage is disposed of on the Croydon plan. E. B. N.

THE CONVERSAZIONE OF THE MINING ENGINEERS.

NEW YORK, *March 2d., 1877.*

Editor ENGINEERING NEWS:

SIR.—The scientific men of the city and vicinity have been greatly interested in the meetings of the Institute of Mining Engineers, held during the last week in the rooms of the American Society of Civil Engineers, and yesterday was to be marked with a white stone in the annals of the society. After listening to topics of interest, the members, bachelors and benedicts, were treated to a new sensation, namely, that of making the acquaintance of a most useful article, a cradle. There be many bachelors in the number, but they are daily growing fewer. For though an engineer is generally expected to "live under his hat" yet, strange as it seems, they most always succeed in persuading some confiding woman to share their vicissitudes. But of the "cradle," it was'nt, after all, that article advertised as "indispensable in every house," but a mighty one, as well it should be, to rock Science in it on the slender wires of the East River Bridge. Those who made the trip seemed highly pleased, and those who did'nt seemed well *satisfied*, to say the least. Last evening the kindness and forethought of Mr. Edward Cooper had arranged a reception to the members of both Civil and Mining Engineers' Organizations, and the invitations were quite generally accepted. The house was well suited in arrangement for the reception of the guests and Mr. C's care for their wants while there was equally salutary and satisfying. Probably no class of scientific men so delight to unbend from the severe duties of active life and spend a social evening in the lighter duties of a social concourse as do engineers; and the higher the rank attained the more do they seem to prize this unwonted freedom. To the truth of this bear witness the many snow-capped heads which last evening congregated under Mr. Cooper's roof. The fathers of the profession they were, some, whose sons are now illustrious—to follow the thought of the classical writer. Among the more prominent might be noted, the genial Mr. Worthen, without whose pleasant smile no convention or convocation seems complete; Squire Whipple, whose bridges are, as they have been for years, the never-failing source of instruction to the student, and his theme for the great work of his life, viz., his graduating thesis; Mr. Coryell, of Pennsylvania, whose name is synonymous with coal-mining enterprise, and has been for a quarter of a century or more; Col. Milnor Roberts, of canal fame, and whose early recollections of Pittsburgh were a source of delight to the convention held there; and many others well known to "fame and story." The army was also well represented by Gen'ls Gillmore and Barnard, Capt. Raymond, of the Engineers and Lieut. —— of the Ordnance Corps. The press was not forgotten, as the pleasant face of Mr. Rothwell of the *Engineering and Mining Journal* would testify. While members from the west and south, Colorado and Louisiana showed their interest by the long journey they had taken. Engineers being non-partizan politicians, no returning board appeared; matters seemed to be reversed, for it was the engineers who returned, and attacked the board, which was thoroughly fortified against all assaults and withstood them manfully. (Mem. Engineers can be relied upon to eat more and faster than any other profession). Mr. Cooper probably knew this idiosyncrasy, and was well prepared for it. In noting the reception, none should forget the hostess and Miss Cooper, who graced the occasion and well supported the master of house in his successful efforts for his guests' pleasure. The venerable Mr. Peter Cooper, whose name is always identified with anything for the good of his fellows, was present, and to whom nothing scientific is believed to be foreign. During the evening he related to several the history of the first engine on the B. & O. Railroad, and of the inception of the Cooper Union. The latter, it might be remarked, is as noble a monument to the memory of a man as heart could desire.

During the evening the Metric System received its due share of attention, and Mr. Worthen showed that nature endorsed it, as illustrated by the digital and pedal members of the body, although at the same time he deprecated the impending change in the Scriptural passage to "No man lighteth a candle and putteth it under a hectolitre." The thought of the many weary hours engineers have spent and will spend in the perusal of the sacred volume, so agitated the writer, that it or *something else* kept him from his nocturnal rest, and being sleepy he withdraws to needed repose, ranking Mr. Cooper's entertainment with those of Mr. Rogers, of Philadelphia, and Mr. Fink, of Louisiville, long to be remembered, and enjoyed in the recollection.

ALPHA.

THE AMERICAN SYSTEM OF LEVEL NOTES.

ANN ARBOR, MICH., *March, 1877.*

Editor ENGINEERING NEWS:

SIR.—I had no thought of replying to your correspondent in the paper of Feb. 3, when he urged the advantage of the style of level notes there set forth, but when I read the endorsement of your Canadian correspondent in the issue for Feb. 24, I felt moved to come to the defence of what I consider the American system. I hold that the less figures one is obliged to make, the less liability there is for error, and the less one is *obliged* to do in the field, if desirous sometimes of economizing time, the fewer the mistakes will probably be. I am not to be understood as advocating mental calculations, to save apparent figures on the pages of a book, but I decidedly prefer that method which requires the least number of simple operations, with a proper check on the accuracy of the work. While I am aware that it is hard to induce one to change the routine methods to which he is accustomed, I am perfectly willing to leave the merit of the notes submitted here to be decided upon by anyone who will give them a fair trial.

The way in which I have been accustomed to keep

level notes is shown in the table below, and is the method given in Henck's Field Book. After the instrument is placed in position the first sight is a + sight

LEVEL NOTES.

Station.	+ Sight.	Ht. of Inst.	— Sight.	Elevation.
B M.	2.619			106.287
24+60		108.906	3.24	105.67
25			5.12	103.79
26			4.78	104.13
27			5.09	103.82
+20			5.90	103.01
28			6.38	102.53
+40			8.27	100.64
29 t. p.	0.364		7.695	131.211
+60		101.575	8.79	92.78
+80			10.20	91.37
30 t. p.	0.298		9.873	91.702
+25		92.000	4.62	87.38
×60			6.28	85.72
31 t. p.			9.237	82.763
	3.281		26.805	23.524
			3.281	
			23.524	

and all the other are — sights, until the instrument is moved; therefore no further attention need be paid to + or —, to rise or fall of ground. The back sight is placed opposite the point on which it was taken, and the "height of instrument" opposite the first station which it concerns. It appears to me as easy to subtract the minus sight from its "height of instrument" as from the number just above, and, when done, I have the desired elevation, in place of a rise or fall which I must add to or subtract from the preceding elevation. And in the latter case I must note whether it is a rise or fall. Herein the *American* method has a decided advantage, that one need not attend to such a point at all.

For a check:—As shown by the footings, add up the plus sights, add up those minus sights which were the last of each series, or which precede each instrument height. (Here the numbers are easily distinguished by having three decimal places; otherwise they may be set in another column, or they may be underscored or checked.) The difference between these two sums will equal the difference between the first and last elevation. As each elevation, except those taken as *turning points*, is independent of the others, and does not affect others, an error in one of the intermediate elevations is not carried through every following one until a check is applied, perhaps to the bottom of the page, as was done in the table of the first correspondent, when an amount of correcting sufficient to disgust one with *rise* and *fall* must be gone through with.

Further, my practice has been, after subtracting the minus sight from height of "instrument," to mentally add the minus sight to the elevation just obtained, as a check, and it can be done almost instantly. If, at any other time, I desire to look over the notes, I run them over by addition, and can go down the page quite rapidly. If the level rod must be read by the rod-man, he should keep notes himself of all readings which affect the general results, as those are the ones which are taken at the greatest distance from the instrument and are most liable to be heard indistinctly. The rod-man's note book for the above table will look as follows:—

CHECK NOTES.

Station.	+Sight.	Ht. of Inst.	—Sight.	Elevation.
B. M.	2.619			106.287
29 t. p.	0.364	108.906	7.695	101.211
30 t. p.	0.298	101.575	9.873	91.702
30 t. p.		92.000	9.237	82.763
	3.281		26.805	25,524

It will be seen that the check is even more easily applied here. I have sometimes required the rod-man to keep a complete duplicate book. If he is at all bright, he can bring his figures up while the leveller is setting up anew. If now the leveller and rod-man compare the last important reading, bench-mark, height of instrument, or elevation, each time that they pass one another, errors which affect any but a single intermediate station can be at once detected. I have pursued this method, found no trouble, made no delay, and kept everything moving. The intermediates may be looked over again at any time, and no running or cumulative error can ever exist. Of course no notes, however carefully kept, will detect a wrong rod reading. If time is lacking, the intermediate elevations need not be carried out till later.

I am afraid, Mr. Editor, of tresspassing too much upon your valuable space, but, as I am upon the subject, I feel inclined to throw out one or two more suggestions. It is convenient, when reading off, to make a profile, to have no elevations in the elevation column except those which are to go upon the profile; hence I have been in the habit of putting the height of bench marks and of turning points other than stations in the next column to the right. Also, as it is desirable to have the final minus and the previous back or plus sight at equal distances from the level, in order to eliminate an instrumental error, and as this cannot always be done on rough ground, but the distances can be balanced in the long run, when the final result is the same as if they had been balanced all along, I used to make a mark in the station column to denote the location of the level, and thus see that a long plus sight at one time should be compensated for by a similar minus sight later, or *vice versa*. Thus if the level is between 27 and 28, make a mark between those numbers showing its relative position, when you can always afterwards recall that you were 150 ft., 175 ft., etc., from 29, and perhaps 265 ft. or 300 ft. from the bench mark, and you can restore the balance of distance at the first convenient opportunity.

I read with pleasure your letters from correspondents, and hope they will be still more moved to give us some notes from their experience. If any typographical errors creep into the above tables, they must not be laid to the *American system*.

J. B. DAVIS.

SPECIFICATIONS AND BIDS OF WESTERN AVENUE IMPROVEMENT, ALBANY, NEW YORK.

GENERAL DESCRIPTION.

On that portion of Western avenue, included in this agreement, the roadway and sidewalks are to be constructed, the curbs set and gutters laid, the labor and materials furnished as is hereinafter more particularly described, all in accordance with the plans and specifications as prepared by the Engineer of the Board of Commissioners of Washington Park.

All material furnished, and all the work done, which, in the opinion of the Committee on "Roads, Avenues and Grading," of said Board of Commissioners of Washington Park, or of their authorized agent, shall not be in accordance with these specifications or plans, shall be removed and other materials furnished and work done that will, in the opinion of the said Committee or their authorized agent, be in accordance therewith.

The sand for the roadway, cross-walks, curb and flag sidewalks shall be of yellow sand similar in character and equal in quality to that used in paving Madison avenue, and shall be free from roots, loam or vegetable matter.

The sand shall be placed upon the road-bed in two successive layers, each six inches in thickness (but only where the road-bed has been brought to the proper subgrade), and each layer shall be well rolled until it is firm and compact. Upon this, when thus compacted, four inches of clean, sharp, black sand, free from roots or large stones, shall be placed, by hand or with barrows from the sidewalk lines, but not by means of carts or wagons.

The curb shall be of the best quality of blue stone. They are to be in lengths of not less than three feet, to be not less than four inches in thickness for the full depth of the stone, and shall be not less than twenty inches in depth the entire length of the stone. The top of the stone shall be cut to a bevel with the front, the front to be cut smooth and to a fair line, without rounding, and with no projection or depression exceeding one-quarter of an inch from the working line to a depth of ten inches from the top. The bottom to be roughed off, parallel to the top, to the full thickness of the stone. The ends from top to bottom shall be truly squared and dressed so that when laid and abutted, the one against the other, the joints shall not exceed three-eighths of an inch in width. All curb shall be hammer-dressed to depths and lines shown on plans.

The hammer-dressing for curb as above specified is that between quarry dressed and fine axed.

The curb for corners shall be of dimensions shown on the plans. They shall be cut to the radii shown, and shall lay to the same thickness of joint as provided for the straight curb. In all other respects they shall be dressed as specified for the straight curb, and shall be of the same quality and character of stone. The length to be paid for such circular curb shall be that measured on the exterior curve of the stone. The curb, both straight and circular, shall be as nearly as possible of uniform color. Where special lengths of either straight or curved curb shall be required, they shall be furnished and paid for at the price paid for ordinary straight or curved curb.

All curb shall be laid truly to the lines and grades, and shall be driven to a firm and unyielding bearing by means of a wooden pounder of not less than 50 pounds weight. The joints between abutting curb shall not exceed three-eighths of an inch in width. The curb shall be backed up with at least one foot of clean sand, which shall be well rammed. All curb shall be set so as to show the front to the depth shown on plan. If, after being set, any curb should break or settle below the finished grade line, such curb, if unbroken, shall be reset—if broken, a new one shall be put in its place without extra cost.

The gutter stone shall be of granite, similar in character and quality to that used for the street pavement, and shall be of the following dimensions: "Not less than three nor more than four feet in length, not less than six nor more than eight inches in depth, and not less than twelve nor more than fifteen inches in width."

They shall be dressed to an even face on the top and bottom, the sides and ends shall be square and full, and be cut so as to lay to a joint not to exceed three-eighths of an inch in width from top to bottom.

The stone shall be well and firmly bedded in the sand provided for the pavement, and shall be driven to their beds by means of a wooden rammer, as provided for the setting of the curb. The stones are to be laid in alternate widths of twelve and fifteen inches respectively, as shown on plans.

All flag shall be of the best quality of blue stone, free from cracks or shakes, not less than three inches in thickness—six feet in length, by from three to four feet in width. They shall be as nearly as possible of uniform color. They shall be smooth and even on the upper surface, the sides dressed clear of drill or chisel holes, and square with the upper surface for at least one inch down. The edges where they abut to be so dressed as to make joints not exceeding one-half of an inch in width.

The stone shall be bedded in eight inches of yellow sand, similar in character and quality to that used for the roadway. They shall be laid truly to the lines and grades given, with close joints, not exceeding half an inch in width, with a true and level surface, the joints to be filled with clean, sharp, black sand, and swept clean on the surface. If any flag shall break within one month after completion of the work, or during the progress of the work, owing to the deficiency of the foundation or imperfect bedding, or through the carelessness of the party or parties to the contract, or of those in his or their employ, such flag stone shall be replaced by a perfect stone, without extra cost.

The stone for the pavement, wheelway or roadway, shall be of granite, of the following dimensions:

"From (3½) three and one-half inches to (4½) four and one-half inches across their upper and lower faces; from seven (7) to eight (8) inches deep, and from (10) ten to (14) fourteen inches in length; but in no case shall they be less than (8) eight inches nor more than (14) fourteen inches in length." The granite of which these stones shall be made must be equal in hardness to Quincy granite, or to that from the quarries of the Pigeon Hill Granite Company.

They shall be laid with their longest dimension at right angles to the center line or axis of the avenue as far as the gutter stone of the avenue; but on streets intersecting Western avenue, they shall be laid with their longest dimension parallel with the center line or axis of the avenue, from the curb line of Western avenue as far as the cross-walk stones, as shown on plan.

They shall break joints in alternate courses, each course of blocks as far as practicable to be of uniform width and depth, and so laid that all longitudinal joints shall be broken by a lap of at least three inches.

They shall be well bedded in the sand provided, and after bedding be rammed with a pounder weighing at least 50 pounds. Their surfaces shall then be covered with a thin layer of clean, sharp, black sand, which shall be thoroughly brushed in to fill up the joints, and they shall again be rammed until there shall be no settlement of any stone below the finished cross-section established.

In case of settlement below such finished cross-section, the stone shall be lifted and reset, and again rammed until they form and set to such finished cross-section.

The joints between the stones shall in no case exceed one half of an inch in width, and the pavement shall, after being thus firmly rammed, be covered with not less than one inch of clean, sharp, black sand, from which the larger stone shall have been removed by screening.

It is particularly specified that the stone shall be as nearly as possible square on all their faces, and that the joints when laid shall not exceed one half of an inch in width, and that no portion of the pavement shall be estimated upon or accepted where the joints between the stones are in excess of the dimensions above specified.

A. The crosswalk stone shall be similar in character and quality to that used for the roadway, and shall be not less than four feet in length, two feet in width, and no less than six inches nor more than eight inches in thickness throughout. They shall be dressed to an even face on top and bottom. The sides and ends shall be square and full, and be cut so as to lie to a joint not to exceed three eighths of an inch from top to bottom.

The stone shall be well and firmly bedded in the manner provided for the stone pavement, on a foundation of yellow sand, similar to that specified for the pavement, and laid with joints as above specified.

The courses are to be laid so as to break joints, and to be separated by two rows of granite blocks similar to those used in the pavement.

N. B.—Bids will also be received for the furnishing of "Belgian" cross-walk stone of sizes specified in A, but parties making proposals for furnishing all the materials and labor under section I of Proposals, must state in such proposals the character and quality of the stone they bid upon, whether it is Belgian or granite cross-walk stone.

The whole of the material to be furnished and all the work to be done under these specifications and plans shall be at all times subject to the inspection and approval of the "Board of Commissioners of Washington Park of the city of Albany," and any material furnished or work done which shall not conform to these specifications or plans, shall be removed or taken up by the contractor or the parties to the contract, at his or their own cost, and other material or work furnished and done which shall be satisfactory.

As the work progresses toward completion the party or parties to the contract shall, from time to time as the engineer directs, clear away and remove from the limits of the avenue all earth, sand, stone, refuse or surplus material of every description, and the avenue shall be left in every respect in clean and orderly condition. Until this has been done, no portion of the work shall be considered as completed.

Work shall be commenced at such time and at such points as the Board of Commissioners of Washington

Park may direct. The work shall be completed in all its parts by the 1st day of October, 1877.

The Board of Commissioners of Washington Park shall be held blameless for any damage to person or property arising from neglect on the part of the contractor or those in his employ.

The following are approximate quantities of material:

Paving—37,408 square yards.
Straight Curb—15,296 linear feet.
Circular Curb—550 linear feet.
Flag—93,828 square feet.
Gutter Stone—16,825 square feet.
Crosswalk Stone—1,130 square yards.
Yellow Sand—18,000 cubic yards.
Black Sand or fine Gravel—6,386 cubic yards.

An aggregate bid for the entire work, including material and labor, will be received.

Also bids for the material and labor, each separate, as follows:

1. For the Grarite.
2. For Stone for curbing and flagging.
3. For all the labor, including sand.

Bids were made under the proposals in two ways: 1. For the entire work complete, including labor and material; and 2. For material and labor separate. The grading is already completed.

There were thirty-four bidders, under one or the other of these heads. They are subjoined as tabulated:

AGGREGATE BIDS FOR ENTIRE WORK.

Sweet, Feeley & Co., Albany	$173,397.40
Patrick McQuade, Albany	144,876.00
John Casey, Albany	154,000.00
Thomas Riley, Albany	136,000.00
James McDonald, Albany	168,000.00
Charles Guidet, New York	189,565 59
Sherman, Flagler & Co., Troy	176,900.00
Stephen B. Trull, Cohoes	134,754.03
John Smith, New York	145,000.00
John McKim, New York	140,000.00
John R. Briggs, Massachusetts	160,000.00
Robert Harrop, Albany	136,627.84
John McDermot, Albany	177,442.25
Wm. Casey, Albany	153,000.00
Jacob Holler, Albany	155,500.00
James Boyle, New York	144,737.00
John Ryan, Albany	138,000.00
Thomas Tawley, New York	151,500.00
Thomas McCann, Brooklyn	139,000.00
McConnel & Jones, Rochester	190,000.00
Geo. Martin & P. Farley, Albany	139,000.00
Alexander Kennedy, Albany	139,975.00
John H. Finn, Albany	141,700.00
F. B. McCarthy, Albany	178,000.00
Edward Grimes, Albany	156,500.00
Patrick Hanlon, Brooklyn	130,303.66

A deduction of $2,000 from all of the above bids is to be made if Belgian stone is used for crosswalks.

SPECIAL BIDS.

John Casey—Sand and labor	$ 25,025.67
Blue stone	25,579.38
Granite	107,405.05
Total	$158,011.60
Jas. H. Y. McDonald—Blue stone	$22,158.20
Spec. bid for Belg. crosswalk	2 847.60
Thos. Riley—Sand and labor	$30,320.53
Blue stone	20,252.66
granite	83,097.60
Total	$133 670.79
Spec. for Belg. crosswalk	2,919.30
McMurray & Weidman—Granite	$95,474.50
John Flagler—Blue stone	$26,581.86
John McKim—Sand and labor	$24,670.11
Blue stone	22,607.12
Granite	83,840.90
Total	$131,118.13
Spec. bid for Belg. crosswalk	2,919.30
Chs. F. North—Blue stone	$24,146.24
Jacob Holler—Sand and labor	$ 26,008.43
Blue stone	25,341.69
Granite	106,2;9.70
Total	$157,629.82
Spec. bid for Belg. crosswalk	2,938.00
John Ryan—Blue stone	$21,029.50
Spec. bid for Belg. crosswalk	2,542.50
Geo. Martin & P. Farley—Sand and labor	$22,133.12
Blue stone	24,493.94
Granite	94,919.05
Total	$141,546.11
John H. Finn—Sand and labor	$25,479.09
Bigelow Blue Stone Co—Blue stone	$25,810.83
Spec. bid for Belg. crosswalk	3,356.10
Thos. McCarthy—Sand and labor	$19,873.08

The Commission had these proposals under consideration for several days, and decided to award the contract to Patrick Hanlon, of Brooklyn, the lowest bidder. As proposed his bid was $130,303.66.

By determining to use the paving block instead of gutter stone, and granite instead of Belgian crosswalks, this aggregate was reduced to $127,000—the sum at which the contract will be awarded.

Mr. Hanlon has associated with him Mr. William H. Baird, and the surities offered are ample.

Inquiries have satisfied the Commission in respect to the competency and responsibility of these gentlemen; and it is believed that the work will be promptly and satisfactorily performed.

WILLIAM S. EGERTON, *Engineer.*

TOMPKINSVILLE, N. Y., *March 1, 1877.*

Editor ENGINEERING NEWS:

SIR.—Agreeable to your request of the 22d ult., I have to enclose herewith a list of the bids received at this office on the 26th ult., for the cut stone work of the Stratford Shoals Light-house. A copy of the detail plans and specifications has also been mailed to you this day. Very respectfully

J. C. WOODRUFF,
Colonel of Engineers, U. S. Army.

Abstract of bids for cut stone for Stratford Shoal Light House, received at opening of February 26, 1877, at office of Engineer, 3d Lt. Ho. Dist.:

Name of Bidder.	Place of Business.	Amount Bid.	Samples of Stone.	Remarks.
E. T. Huston	Groton, Conn	$2,559 00	None sent.	Informal bid, wholly so.
M. K. Chase & Co	Bluehill, Me	2,750 00	Very good.	
Pierce, Glover & Co	Granville, Me	3,070 00	" "	
Granville Granite Quarry Co	Granville, Me	3,200 00	" "	
Noland & McGrath	New York	3,249 00	Informal bid.	
Hallowell Granite Co	Hallowell, Me	3,333 00	Very good.	
Smith Granite Co	Westerly, R. I	3,351 86	" "	
Concord Granite Co	Boston, Mass	3,450 00	" "	Certificate.
John S. Hopkins	Vinal Haven, Me	3,495 00	" "	"
John Beattie	Guilford, Conn	3,575 00	None sent.	
Chas. P. Chapman	Westerly, R. I	3,700 00	Very good.	
W. & J. Beattie Jr	Fall River, Mass	3,700 00	" "	
Chas. F. Stoll	New London, Conn	3,073 00	Good.	
D. V. Howell	New York	3,697 57	"	" wholly.
Rodwell Granite Co	Rockland, Me	4,083 00	"	" Certificate.
F. A. Ingerson	New London, Conn	4,140 00	None sent.	
E. Vesecott & Son	North Haven, Me	4,238 00	Good.	
Cape Ann Granite Co	Gloucester, Mass	4,825 66	"	
Bay State Granite Co	Rockport, Mass	4,896 61	"	
Fall River Granite Co	Fall River, Mass	4,980 00	"	
Plummer Granite Quarry	Northbridge, Mass	5,450 00	"	
Rothwell & Co	Washington, D. C	6,987 00	"	bid.
Jas. M. Andrews	Biddeford, Me	7,000 00	"	Certificate.

For Stone Superstructure, Water Works. Lake Crib, Cleveland, Ohio:

Name of Bidder.	Place of Business.	All Lime Stone.	1st, 2d, 3d, Courses Lime Stone, others of Sand Stone.	1st, 2d, 3d Courses Medina Sand Stone, others of Sand Stone.
Farris & Garfield	Painesville, Ohio	$83,465 00	$85,000 00	$89,000 00
Geo. M. Smith	Cleveland, Ohio	77,500 00	75,000 00	77,000 00
A. A. McDonell	Chicago, Ill	53,530 00	54,544 00	57,000 00
E. D. Delamater	Cleveland, Ohio	81,000 00	80,000 00	85,000 00
Geo. S. Hebard	Chicago, Ill	80,674 00	66,670 96	70,000 00
C. H. Strong	Cleveland, Ohio	73,650 00	66,660 00	72,700 00
Jno. E. McMahon	Cleveland, Ohio	76,500 00	69,300 00	75,400 00

Contract awarded to A. A. McDonell. Kind of stone to be used not yet determined.

J. WHITLAW, *Supt. and Engr.*

BOSTON *March 1, 1877.*

Editor ENGINEERING NEWS:

SIR.—I send a statement of the bids received in answer to the advertisement last week. We consider the price very low. The total amount of contract No. 1 is $73,392.00; No. 2 $71,408.00; No. 3 17,582.40.

Yours respectfully,
DEXTER BRACKETT,
Assistant Engineer.

Bids for Cast-iron Water pipes, received March 1st, 1877:

Contract No. 1.	Jesse W. Starr & Sons, Camden, N. J.	R. D. Wood & Co., Philadelphia, Pa.	Gloucester Iron Wrks, Gloucester City, N. J.	McNeals & Archer, Burlington, N. J.	Warren Foundry & Machine Co., Phillipsburg, N. J.	Lake Shore Foundry, Cleveland, O.	Dennis Long & Co., Louisville, Ky.
2,200 tons 48" pipe, 1" thick							
110 " Special castings							
Contract No. 2.							
1,300 tons 48" pipe, 1¼" thick							
260 " " 12" " class B							
260 " " 12" " " A							
385 " " 6" " " B							
75 " " 4" " " B							
140 " Special castings in connection with 48" pipe							
Contract No. 3.							
279 tons 12" pipe, class B	30 00	30 60	30 91	35 50	30 00	35 00	
30 " " 10" " " B	30 00	30 60	30 91	35 50	30 00	35 00	
100 " " 8" " " B	30 00	30 60	30 91	35 50	30 00	35 00	
120 " " 6" " " B	30 00	30 60	30 91	35 50	30 00	35 00	
74 " " 4" " " B	30 00	30 60	30 91	35 50	30 00	35 00	
*Awarded to.	27 00	29 30	29 91	35 50	30 24	$35 00	34 00
	30 00	$32 20	30 73	$37 00	$32 60		
	30 00	55 00	73 91	67 50	51 00		
	30 00	29 60	30 73	35 50	30 22	35 00	34 00
	30 00	30 30	30 91	35 50	30 22	35 00	34 00
	30 00	30 30	30 91	36 00	30 22	35 00	34 00
	07 20	54 40	67 91	75 00	48 84	35 00	34 00
	Price per ton of 2,240 lbs.				per ton of 2,000 lbs.		

PONTIAC, MICH, *March 1, 1877.*

Editor ENGINEERING NEWS:

SIR.—In compliance with your request, I forward herewith a synopsis of proposals received and opened yesterday for gas fitting and gas works for the Eastern Asylum,

Some of the bidders made more than one proposal, varying the amounts according to specifications prepared by themselves.

Berry Brothers' proposal for gas fitting was conditioned upon their receiving the contract for gas works also.

The contract for gas fitting was awarded to James McEwan & Co., they being the lowest bidders.

The Board took until their next regular meeting, March 13, to consider proposals for gas works.

C. M. WELLS, *Sup't.*

For Gas Fitting and Gas Works for the Eastern Asylum for the Insane. To supply gas for 970 burners:

James McEwan & C.o, Detroit, Mich., gas fitting, $2,156.00; Detroit Metal and Plumbing Works, Detroit, Mich., gas fitting, $2.198.15; Monat & McDonald, Detroit, Mich., $2,375.00; Waite & Williams, Toledo, O., gas fitting, $2,495.00; Ferguson, McKay & Co., Detroit, Mich., gas fitting, $2,600.00; Holmes & Webster, Detroit, Mich., gas fitting, $2,600.00; W. D. King & Co., Pontiac, Mich., gas fitting, $2,750.00; Berry Brothers, Detroit, Mich., gas fitting, without meter, $2,075.00; Berry Brothers, Detroit, Mich., gas works, $5,000.00, $3,600.00, $4,500.00, $3,000.00; Gilbert & Barker M'f'g Co., Springfield. Mass., gas machine, $4,000.00; Kerr Murray, Fort Wayne, Ind., gas works, $7,650.00. $6,-750.0., $1,450.00, $4,000.00; W. W. Gibbs, Boston, Mass., gas works, $5,900.00; Thomas H. Hicks, London, Ont., gas works, $9,000.00, $6,300.00; J. D. Patton, Hicksville, Ohio, gas works, $10,300.00. Allen A. Ravenaugh, Detroit, Mich., Agent Pontiac Gas Co., proposes to supply gas at $2.50 per thousand feet.

F. E. Walker, Secretary of the School Commission, Bedford, Iowa, informs us that J. C. Woodruff, not signing contract and bond within the ten days allotted him for the building of the School House, the Board awarded the contract to J. W. Combs, of Bedford, for $15,300, on March 6th.

Messrs. H. A. Ramsey & Co. were recently awarded the contract to construct an iron truss bridge over the Baltimore & Potomac Railroad at its intersection with Argyle avenue, Baltimore, for $11,000. The only other bid was by Wendell Bollman, at $12,311. The bridge will be 112 feet long and 60 feet wide, in three spans, with trusses 8 feet deep, a roadway in the centre and two footways on both sides.

REMOVAL OF THE ROCK OBSTRUCTING THE ENTRANCE TO EAGLE HARBOR, LAKE SUPERIOR.*

BY L. W. SCHERMERHORN.

The port of Eagle Harbor is situated on the northwest shore of Keweenaw Point. It is the receiving and shipping port for a large number of copper mines and the only port affording harborage between Portage and Marquette, a distance of about 140 miles. The shores in the vincinity are rocky and bold, dangerous to approach during northerly gales. A rocky escarpment forms the shore line, extending many miles on each side of Eagle Harbor, and in the submerged ledge across the mouth of the Harbor forms the obstruction under consideration.

Geologically the formation belongs to the Silurian, the rock immediately forming the obstruction to the Harbor is *trap* intersected with veins of chlorite and quartzite. The stratification has a dip of 21°, the rock is exceedingly hard, with a close and crystalline texture. The rock forming the bar rises rapidly on the outside from a depth of 30 feet to a depth of about 8 feet on the crest, and again slopes to a depth of 30 feet within the Harbor.

The width of the proposed improvement is 130 feet, and having a depth of at least 14 feet below low water surface of 1868, or about 16 feet below average summer level.

The area covered by work is 32000 square feet, and required the removal of 3000 cubic yards. The work has been done by the United States Government by day's labor.

The following plan was adopted:

1st. Iron tripods resting upon the bottom and giving support to a platform carrying:—

2nd. Steam drills, steam being furnished from a boiler placed on a scow, which when working was moored along side the platform.

3rd. The use of Dynamite as an explosive and the subsequent removal of the rock by dredging:—

The tripods consisted of bars of railroad-iron 25 feet in length, and weighing 19 pounds per linear foot.

In the construction of a tripod, 3 bars were securely chained together near their upper ends, the lower ends being spread apart forming in plan the apexes of an equilateral triangle whose sides were 20 feet, the legs of the tripod being maintained in their spread position by horizontal timbers clamped to the rails. Eight such tripods gave support to the drilling-platform. The tripods were placed 33 feet apart each way. The drilling platform consisted of 12-inch by 12-inch timbers, 36 feet in length. They were slung to the tripods by a ⅝-inch chain. A pair of 12-inch by 12-inch timbers, 36 feet in length, carried the drilling-frame. It consisted of a frame of 3-inch crossed planks, upon which the drills were placed.

The operation of handling the drills was, briefly, as follows:

The tripods and drilling-platform being in position, the pair of 12-inch by 12-inch timbers were laid in place and the drilling-frame placed thereon. The drills were then hoisted by the derrick and steam-hoist from the deck of the scow, and lowered to their place on the drilling-frame.

On the completion of a hole, a light block and fall enabled two men to easily and quickly slide the drilling-frame carrying the drill in position for another hole.

Upon the completion of a row of holes, the pair of 12-inch by 12-inch timbers, with drilling-frame and drills, were in the same manner moved sidewise for a new row of holes. This method obviated the necessity of lifting and moving drills weighing 850 pounds by hand.

On account of the spring caused by the blows of the drills, it was found necessary to support the main timbers at a point midway between the tripods. This was done by a vertical spar or post resting upon the bottom, and attached to the timbers of the platform by a chain and turn-buckle, allowing any desirable part of the weight to be imposed upon the post.

The platform was practically rigid and but little motion observed, even when both drills were running on the same part of the platform.

When the area covered by the platform had been drilled, the chains by which the 12-inch by 12-inch timbers were slung to the tripods were slackened allowing the timbers to fall into the water; by the derrick and steam-hoist, which were placed on the scow, the tripods were placed in their new position, the timbers floated into place, and likewise raised and attached.

It was not usual to interrupt drilling during the removal of the platform, since two or more tripods could be moved as soon as the area under that part of the platform had been drilled. The upper surface of the platform was about 4 feet above the water. It would be proper to add here that the platform could not be maintained intact during the heaviest northerly gales, at which times it, including the tripods, was overthrown, the loosened timbers being driven inside the harbor, where they were easily regained; the entire overthrow of the platform seldom delaying possible drilling more than ten hours. In two cases tripods without any attached platform were overthrown. The drills used were the "Improved Ingersoll," and of the size known as 5-inch, (referring to diameter of steam-cylinder); each drill weighs, with tripod, 850 pounds.

The drill-steels consisted of octagonal steel, 1¼ inches and 1¼ inches in diameter, of the length of 10 feet, 13 feet. 16 feet, 19 feet, 21 feet and 23 feet.

The size of the bitts was 3 inches, 2 and ¼ inches, 2½ inches, and 2¼ inches in diameter. The holes were begun with the largest sized bitt belonging to the length of steel required, reducing with successive steels. This was necessary on account of the wearing of bitts, producing thereby a hole gradually lessening in diameter.

As is so frequently the case the real difficulties arose from apparently insignificant causes—in this case it came from the gravel and boulders covering the surface of the rock, for a depth of from 1 to 2 feet—without some means of protecting the holes drilled, from this gravel the work would have been idle, for unless guarded against the pebbles would fall in the hole above and around the bitt and either preventing the withdrawal of the bitt, or immediately filling the hole when withdrawn.

After many experiences the following device was used with perfect success. It consisted of a cast-iron disc, 15 inches in diameter, with low legs, and having a weight of about 150 pounds. Through a hole in its center passed an iron pipe 4½ inches exterior diameter, and prevented from withdrawing through the casting by an enlargement at lower end; the pipe was about ½ an inch smaller than the hole through casting, thereby allowing considerable adjustment between the two, in the final position taken by the casting on the bottom. By ears attached to the upper end of the pipe light ropes were carried up to the drilling platform; its operation was as follows: After the adjustment of the drilling steel, and before starting the hole, the pipe and attached casting was lowered over the head of the steel and allowed with slackened ropes to rest upon the bottom. The early blows of the steel knocked aside the boulders and gravel allowing the pipe to follow down to the rock. The early blows of the drill produced a hole at starting something larger than the cutting edge of the bitt thereby allowing the pipe to enter a short distance into the rock and perfectly excluding the drift from the hole. The feed of the drills was 3 feet, after which a steel 3 feet longer was introduced. With the introduction of the second steel another pipe, with exterior diameter just sufficient to pass within the pipe attached to casting, was dropped over the second steel passing inside of the larger pipe and into the hole already drilled for a depth of from 1 to 2 feet. Successive steels were introduced until the hole had reached the required depth.

After the withdrawal of the last steel the casting and attached pipe was lifted, by the attached ropes, over the smaller pipe, leaving the latter fixed in the hole. A new hole was started and the process continued until a section was completed—usually 16 holes. These smaller pipes remained in the holes until they were charged and only withdrawn just previously to firing. By this method a hole was rarely lost by filling with gravel. This device had been previously used at Ahnapee, Wis.

The *boiler* furnishing steam to the drills and hoisting-engine was a locomotive boiler, 12 feet in length, 3 feet in diameter, with 30 3-inch flues, and rated at 25-horse power. It furnished with ease all power required. The consumption of fuel was about half a cord per day of half dry soft wood; a pressure of 65 pounds was required for the proper working of the drills; with this pressure from 180 to 250 strokes were given per *minute*. The scow held the boiler, derrick, hoisting-engine, portable forge and anvil, air-pump, and such other tools and supplies as were in immediate use. It was 80 feet long, 16 feet wide, and 5 feet high. It served as a working base in all the operations of the work. Its position during drilling was closely adjacent to the platform, where it was held in smooth weather by lines thereto attached, and in rough weather by a bow anchor permanently placed outside the entrance, a side anchor and a stern line attached to dock. The scow was moved by means of a winch-head attached to the winding shaft of the hoisting-engine, and so arranged as to run either when the winding drum was in motion or at rest. In moving the scow from the dock to platform, a distance of 1,000 feet, the line from the bow-anchor passed around the winch-head, while the stern or dock line was paid out. In returning the operation was reversed. It required about fifteen minutes to move in or out.

The holes were drilled 3 inches in diameter at the top, reducing about ¼ inch each 3 feet in depth. They were drilled to a depth of 16 feet below low-water surface of 1868, being 2 feet below bottom of proposed excavation. The holes were drilled nearly vertical. Oblique holes would have conformed better to the stratification, and given greater lift in blasting; still the spring of the steels and the difficulty of direction and management would more than offset the advantage gained. The character of the rock was such as to make the rate of penetration very irregular; at times it would be as high as 0.5 feet per minute, at others as low as 0.01 foot per minute. This latter rate was due to veins of quartzite and veins of conglomerate; in the latter, small pebbles becoming detached from the sides of the holes, fell in above the bitt, causing a difficulty both in progress and withdrawal. At times small masses of copper entirely stopped the penetration of the drills.

The explosive used was Dynamite, of two qualities, viz., No. 1 and No. 2:

No. 1 containing about 75 per cent. nitro-glycerine.

No. 2 containing about 36 per cent. nitro-glycerine.

The cartridges were of the following dimensions:

No. 1 cartridge, 1¼ inches diameter, 8 inches long; weight, ½ pound.

No. 2 cartridge, 1¼ inches diameter, 8 inches long; weight, 1 pound.

From 6 to 16 holes were fired at once. The detonation was not excessive, and fragments of rock never appeared above the surface.

The firing was done by Mowbray's frictional battery.

The holes were generally placed 7 feet apart each way, and drilled to a depth of from 3 to 4 feet below proposed bottom. They were charged with about 12 1-pound cartridges of No. 2, and from 4 to 6 1-pound cartridges of No. 1. The former were placed in the bottom of the hole, the latter on top; the upper cartridge contained the exploding cap.

The cartridges were introduced into the holes by a diver and rammed well down by a landing pole operated from the platform above.

The scow was usually moved back from 50 to 100 feet from the area exploded. The cartridges were frequently left in the holes 24 hours before firing; a limited action of water did not seem to produce any injurious effects.

The dynamite was handled with due regard to the fact that it was an explosive but with less care probably than would have been used in the case of black powder, from an experience of two years I should prefer—in the matter of safety alone—to use dynamite to black powder.

The exploder used consisted of a copper cap filled with about 25 grains of fulminate of mercury.

The force employed on the work was as follows:

1 overseer, 1 fireman, 1 blacksmith, diver, divers attendant, 2 drill runners, 2 drill helpers, 2 jobbers; in all 11 men. 2 drills were generally kept running; this force was found sufficient except in the rough weather of the fall. The working season is short, since the harbor opens about the last of May; and the fall storms beginning about September 15th, practically close the season; from 3½ to 4 months comprise the possible working season.

The work has been twice let by contract, and each time the contractor has failed to produce practical results.

The first contract for the removal of the rock was let in 1867, for $58 per yard; the second in 1869, for $40 per cubic yard; the work will be accomplished under the present plan for less than $10 per yard.

The following detailed statement of the last years work will be of interest. It is prepared from carefully kept records of the work during the past two years:

Aggregate depth drilled	4044.	ft.
Average " of holes	6.0	"
Aggregate area drilled over	26000.	sq "
Average depth drilled per hour	3.7	"
Average amount No. 1 dynamite per hole	3.0	lbs
" " No. 2 " "	12.0	"
Number of steels sharpened	790.	
Loss of steel by wear and sharpening	91.	lbs.
Average depth drilled per steel sharpened	5.1	ft.
Cost per lineal foot drilled (including labor, steel used, fuel, oil and coal, also labor in erecting and maintaining platform)	$0.70	
Cost per lineal foot drilled and blasted (including labor, steel, fuel, oil, coal exploders and dynamite)	$2.30	

The above does not include investment, or depreciation of tools or machinery. The approximate cost of machinery, tools and supplies used and on hand is $12,000.

Common labor has been paid from 17 to 18 cents per hour, skilled labor from 20 to 25 cents per hour.

*Paper read before the Civil Engineers' Club of the Northwest, March 5, 1877.

ARCHES;

CONSIDERED GRAPHICALLY.

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(*Continued from page 50.*)

33. The true curve of equilibrium for the load uniformly distributed along the rib is a curve which will be *tangent* to the sides of the funicular polygon just drawn. The closer together the points D, E, etc., are taken, the nearer the two will come together. If the points at which the loads are concentrated divide the span into equal portions, that is, if the end distances are the same as the others, so that the portions of load near B and C are concentrated on those joints, the true curve of equilibrium will pass through the *vertices* of the funicular polygon. Such a distribution of load is made in bridge trusses and roofs, when a half panel weight is thrown on each abutment. The curve assumed by a rope or chain, of uniform weight per foot, when suspended between two points is called a *catenary*. Since the curve of equilibrium, in Fig. 6, if we had not placed the extra weight on D, would have come quite near to the rib, this curve would have been a close approximation to a catenary. As we expect to make some use of this curve later, we will show how to draw one at that time.

If the load on this arch were distributed uniformly horizontally, the curve of equilibrium would be a parabola. In case the whole arch were a parabola with the vertex at the crown, and the load extended over the entire span, the two curves coinciding at the springing points and the crown, would be identical throughout, and the rib itself would be in perfect equilibrium.

34. That the parabola is the curve of equilibrium for a continuous load, distributed uniformly horizontally, may be shown as follows :—Let A B, Fig. 7, be a portion of a cord, horizontal at A, which is in equilibrium under such a uniform load, represented by A C. The tension at A will be in the line of the tangent A C; the resultant of the load A C will be vertical and must pass through its middle point D. As the cord A B is in equilibrium under its load and the reactions or tensions of the other portions of the cord at A and B, the tension along the tangent at B must, by § 1, also pass through D.

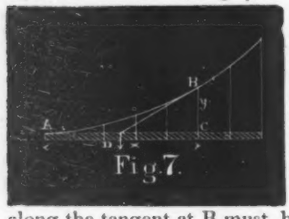


Fig. 7.

As B C, drawn vertically, is parallel to the resultant of the load, the sides of the triangle B C D will be proportional to the three external forces, and, if A C = x, B C = y, W = total load on A B, = $w\,x$, (where w = load per unit of length), and H = tension at A, we have

$$W : H = B C : D C = y : \tfrac{1}{2}x,$$

$$\text{or, } y = \frac{W\,x}{2\,H} = \frac{w}{2\,H}\,x^2,$$

the equation of a parabola with vertex at A.

Therefore an arched rib of parabolic form, when loaded uniformly horizontally, has no tendency to change its shape, or experiences no bending moment, at any point.

35. If the load extends over a portion only of the span of the arch, and is uniformly distributed horizontally, the curve for the loaded portion is parabolic, while that for an unloaded portion will be a straight line ; thus, if the load extends from one abutment to the middle, we shall have, on the unloaded half, a straight line from the abutment to the crown, and, on the loaded half, a parabola from the crown to the springing. As it will be seen from the funicular polygons of Figs. 1 and 2, that any two sides of the funicular polygon, when prolonged, meet on the vertical drawn through the centre of gravity of so much of the weight as is included between these sides, the curves of equilibrium for any cases where the rib is hinged at three points can be drawn without previously determining the value of H. Thus, in the case just supposed, of a load over the half span, from B to F in Fig. 5, the centre of gravity will be at G. Then if G C is the vertical drawn from G the side of the funicular polygon, or, more properly, the tangent to the curve of equilibrium, at B must pass through C, where C G meets A D, and the required parabola will be drawn from D to B on D C and B C as tangents. As one point of the curve we have the middle point of the line from C to the middle of the chord D B. We can then turn round and find H by drawing 1-0 and 2-0, parallel to A C and C B. Henck's "Field Book for Railroad Engineers," gives methods for constructing parabolas, and we shall cite another presently. A handy construction when two tangents are given, as in the present case, may be found in "Graphical Analysis of Bridge Trusses," p. 19, § 10.

36. We would suggest the following examples for practice. Given a semicircular rib, loaded uniformly horizontally over the whole span, and pivoted at the crown and springings ; the maximum bending moment occurs at 30° from the springing and is equal to one-sixteenth of the total load multiplied by the radius of the arch, while H is equal to one-fourth of the total load. Given a parabolic arch similarly pivoted, and in equilibrium under a steady load distributed as above; add a similar travelling load from one abutment to the middle of the span; the maximum bending moment is found at one quarter of the span from either abutment, is of opposite signs at those two places, and is equal to one-thirty-second of the travelling load then on the arch multiplied by the span, while H for the travelling load equals the same quantity divided by one-fourth the rise of the arch, and for the steady load is twice as much.

37. It may be desired, when designing an arch of this type, to find the extent of load which will produce the maximum bending moment at each point, and the value of that moment. Suppose the point N, Fig. 5, to be examined:—Prolong B N until it meets A D at E; it is then manifest that any load in the vertical through E will cause no bending moment at N; that any load on the right of E will have its curve of equilibrium outside of the arch at N, while loads to the left of E will cause the curve of equilibrium to pass inside of N. Therefore the maximum bending moment at N of one kind will be found when all possible loads are put on the arch from B to the vertical through E, and the maximum moment of the other kind occurs when the load extends from A to E. As the arch tends to move away from the curve of equilibrium, the kind of moment is easily distinguished. H can then be found, the curve of equilibrium drawn, the ordinate scaled and multiplied by H.

38. For the reason that the curve of equilibrium is at once definitely located by introducing three hinges or pivots, no matter what form the arch may have, that type which used to be known as the braced arch, with a horizontal upper and a curved lower member, the spandril being filled with bracing, has usually been treated as free to turn at both crown and springings; then a diagram may be drawn by Clerk-Maxwell's method, or the stresses may be found from the curve of equilibrium. While a diagram only gives the stresses in the various members for one position of load at a time, by a tabulation, not difficult to one familiar with such methods, and two diagrams one can determine all the maxima stresses. The way to be pursued will be found in Du Bois' "Graphical Statics," Appendix, § 7, p. 350.

39. To find that portion of the shear at any section which is resisted by the web or braces, we can draw a line in the stress diagram parallel to a tangent to the rib at the desired point, and deduct the amount of the load line intercepted between it and the extremity of H from the total shear, or resultant of vertical forces, as already explained in §§ 19 and 20, and the remainder will be the desired vertical component of the stress in the web. It is not practicable to draw a shear diagram unless the form of the rib is previously defined; therefore, after we have discussed the parabolic and circular ribs, the reader can doubtless work up any special design of this class for himself. The tabulation and the diagrams will be similar to the ones then produced, but easier to be constructed. We have not cared to demonstrate at this time the truth of certain statements in the preceding sections, which conveniently came in this connection, because we expect they will become evident as the work progresses, and they are not essential to the line of argument.

One advantage possessed by this type of arch is that changes of temperature have no straining effect, for the crown rises and falls without affecting the two halves of the arch injuriously. If the crown sinks a little, the value of H will be seen, from Fig. 5, to be very slightly increased, while the curve of equilibrium will practically go with the arch.

40. We propose to apply the facts which have been developed thus far to the arch whose centre line is a parabola. This curve is chosen as one form because it is, as proved in § 34, in perfect equilibrium under a load distributed uniformly horizontally over the entire span. As in the case of a suspension bridge, so in some arches of iron, the major part of the steady load consists of a platform and such other parts as are distributed in accordance with this requirement, (the arch itself and the vertical posts which carry the platform giving a somewhat greater intensity per horizontal foot as we approach the springings), so that for the former portion as well as for the travelling load over the whole span, the arch will be subjected to no bending moments, and there will be no stress on the bracing. Then again, the parabola for a given rise and span is easily plotted and designed; and lastly, the determination of the curves of equilibrium, for the cases taken up, will be simpler than for circular arcs, and will naturally prepare the way, by rendering the reader familiar with the steps of the analysis. It may be well to add here that a circular segmental arch whose rise is not more than one-tenth of its span is so nearly coincident with a parabolic arch of the same span and rise, that the investigations which follow will apply with sufficient accuracy to such flat segmental ribs.

(*To be continued.*)

THE ASHTABULA DISASTER.

VERDICT OF THE CORONER'S JURY.

After a large number of sessions, extending over a period of more than two months, the coroner's jury, convened for the inquest on the victims of the Ashtabula accident, brought in a verdict, on March 8, which is given in substance below. Much testimony has been taken, and the case has apparently been very carefully considered. The findings will be seen to differ materially in their imputations of blame from what many have come to expect as the result of an ordinary inquest. The jury have employed no uncertain phrases and the verdict is in harmony with the convictions of all competent persons who have inspected the wrecked structure or studied the expert testimony. We have heretofore reproduced in our columns the most material portions of the evidence, and a consideration of those extracts, together with the clear description of the sizes of parts and the methods of joining and fastening, which we quoted in our issue of February 17, p. 46, from the letter of Mr. E. S. Philbrick, C. E., will enable our readers to judge of the facts for themselves.

At a time when the knowledge of the theory and practice of iron bridge construction was not nearly so widespread as at present, indeed when bridges of that material were comparatively rare, although engineers could then have been found of sufficient experience and competent to advise on the proportions and details of the contemplated design, the designer of this bridge undertook to improve on the wooden Howe truss with which he was familiar by substituting iron throughout. The top chord and braces were therefore made up of an assemblage of six inch I beams, bearing an analogy to the separate strands of a wooden top chord, and to the sticks of timber used in the diagonals. Cast angle blocks were retained, modified to suit the number and arrangement of the abutting pieces, and, upon the bridge proving weak, additional braces of the same character were added, the additions requiring some other work, in the way of chipping and cutting, which could not fail to be detrimental.

There was a decided lack of any means of making the several pieces which were placed side by side act as one member, the thimbles and yokes which correspond to the packing blocks and bolts of timber construction being entirely insufficient for the purpose. The fact also that the ratio of the length to the least diameter of a compression member has a very serious influence on its power of resistance to strain seems to have been unknown or lost sight of. It is agreed that there was sufficient iron in the bridge, but that, through injudicious arrangement, and a division of a member into several parallel pieces, almost independent, instead of a disposition of its material in such a form as to adapt it to withstand a thrust, this iron, in place of being a source of strength was an element of weakness by reason of its dead weight. The bridge is estimated to have weighed from 3,000 lbs. to 3,200 lbs. per lineal foot. We might call attention to other points of faulty construction, but will leave our readers to make such calculations for themselves, from the data given in the paper referred to above, as will satisfy them of the different points of weakness in the design.

The verdict was preceded by the following statement:

"It is from a careful consideration of the evidence elicited from professionals and experts that our verdict is made up in the matter of the bridge, and should it seem severe upon the railway company, or upon any of its past or present officials, it is because the truth, as shown by the evidence, demands it at our hands. We cannot do less and feel that we have discharged our duty. Mr. Amasa Stone, president of the company at the time of the erection of this structure, had been for years a prominent and successful railroad contractor and builder of modern Howe truss bridges. With the undoubted intention of building a strong, safe and durable wrought-iron bridge upon the Howe truss plan, he designed this structure, dictated the drawing of the plans and the erection of the bridge without the approval of any competent engineer and against the protest of the man who made the drawings under Mr. Stone's direction, assuming the sole and entire responsibility himself. Iron bridges were then in their infancy, and this one was an experiment which ought never to have been tried or trusted, to span so broad and deep a chasm. This experiment has been at a feaful cost of human life and human suffering. Unquestionably Mr. Stone had great confidence in his own abilities, and believed he could build and had built a structure which would prove the crowning glory of an active life and an enduring monument to his name. The testimony of competent and skillful engineers is, that subjecting an iron bridge to a severe strain as a test before using it in carrying on the traffic of a railroad is of no value as showing its ability to bear repeated strains. It only shows that it bore the test that time, and it may have permantly crippled it so that its final failure was only a question of time. The sure rule is to have a large margin of safety as shown by a careful computation and distribution of the strains. That the officials of the railroad regarded the bridge as safe we have no doubt as two of them were on the train that went down, and all were more or less frequently passing over it."

Then follow the several findings, the portions which are of professional interest being as here given. In addition, the verdict holds the railway company responsible for failure to comply with the State law of May 4, 1869, in regard to heating apparatus so constructed that the fire in it shall be extinguished upon the car being wrecked; it also attaches blame to those persons who failed to apply water to the burning cars by means of the steam pump and fire engines. The jury states that the fall of the bridge was the result of defects and errors made in designing, constructing and erecting it. A great defect, and one which appears in many parts of the structure, was the dependence of every member for its efficient action upon the probability that all, or nearly all, the others would retain their position and do the duty for which they were designed, instead of giving to each member a positive connection with the rest, which nothing but a direct rupture could sever. The members of each truss were, instead of being fastened together, rested upon each other. Other defects were: the deficient cross-section of portions of the top chords and some of the main braces; the insufficient strength and bad arrangement of both the horizontal and vertical transverse bracing; the construction of the angle-blocks as finally modified without sufficient lugs or flanges to keep the ends of the main and counterbraces from slipping out of place; the construction of the packing and yokes used in building together the main and counterbraces at the points where they crossed each other; the shimming of the top chords to compensate for the deficient length of some of their members; the placing during the process of erection of thick beams where the plan required thin ones, and thick ones where it required thick ones.

That the railway company used and continued to use this bridge for about eleven years, during all which time a careful inspection by a competent bridge engineer could not have failed to discover all these defects. For the neglect of such careful inspection the railway company above is responsible.

That the responsibility of this fearful disaster and its consequent loss of life rests upon the railway company which, by its chief executive officer, planned and erected this bridge.

TREE PLANTING ALONG RAILROADS!

The planting of trees along the lines of the Central and Southern Pacific Railroads is a most creditable step. The *Eucalyptus* has already been set out on quite a large scale; the *Catalpa* will also be tried, and it is hoped that ties and fence posts can be obtained from them both in due time. The *Eucalyptus* is of rapid growth, and therefore well adapted for the purpose, as the wood is of excellent quality. The influence of the trees on the soil and climate is expected to be very favorable, and they may affect the rainfall in some of the waste and arid lands which border upon the railroads, and thus benefit the company. It is thought by many that forests have a marked influence upon the annual rainfall of countries; there is no doubt that they mitigate or almost prevent floods by the retention of the water, and lessen the evaporation by their shade, so that the neighboring sections may become available for agriculture. To bring about such results very extensive planting and tree protection must of course be inaugurated. The San Francisco *Bulletin* makes some interesting statements as to the steps now being taken in this direction along the above railroads, and we quote some of their remarks on the *Eucalyptus*.

After speaking of the *Eucalyptus globulus*, already planted, and almost the only species to be at present found to any extent in this country, it adds:

The *Eucalyptus marginata*, which for some time has been extensively exported from the southwest of Australia and used for railway sleepers, will be set out along the hilly tracts and ledges along the roads. The *Eucalptus rostrata*, which grows in southern Australia, and in places of which the climate and character is very similar to the redwood districts of California, will be used for river bottoms and wet lands generally. The *Eucalyptus brachypoda*, which flourishes in the arid, tropical inland regions of Australia, will do equally well, it is thought, in the desert tracks of California; and the *Eucalyptus obliqua*, which rapidly attains gigantic dimensions in the poorest of soils, and can be used for almost any purpose above ground, will be set out in those places along the railroads where the other eucalypti will not thrive. The wood of all these eucalypti, with the exception of the last named, is exceedingly tough and heavy, and owing to the resinous gums with which it is saturated, it is almost impervious to decay, and can, for this reason, be used with great advantage for sleepers and telagreph poles. Sleepers of the *Eucalyptus restrata* have been known to last over twelve years, and the wood of most of the other eucalypti is said to be a little inferior in respect to durability. It is the intention of the companies to set these trees out in triple rows on each side of the tracks, from six to twenty feet apart.

The rapid growth of all the eucalypti is one of their most marked features, and one which makes them especially adapted to such a purpose as that to which the railway companies now propose to apply them. In Algiers the average growth of a young eucalyptus is nineteen inches per month, and a two-year-old tree is frequently twenty feet in height. Supposing that the trees will grow as rapidly in this country, by the time the work of setting out the trees along the road is completed the small eucalypti that are now just starting up along the railway in Alameda county will have attained the size of ordinary trees, and only a few years will have to elapse after the completion of the work before the purposes for which the eucalypti are to be planted will be realized.

FROM the annual report for 1876, of D. Farrand Henry, Chief Engineer of the Detroit, Michigan, water works, we glean a few facts of interest. Total pipeage of the city, 187½ miles, of which 94⅗ miles is iron pipe and 92 and 5-6ths miles wooden logs. The present pumps and mains will supply about 22,000,000 gallons in twenty-four hours; but if a little time is taken for cleaning and rest as at present, not over 20,000,000 gallons a day could be furnished. If the city grows in the future as in the past, this limit will soon be reached, and unless another pump and main are shortly commenced, some cold winter's day both the old and new works will have to run to supply the demand. Families assessed 20,102; not assessed, 364; showing that nearly the whole city is supplied with water. The number of gallons of water pumped this year was 142,119,790 less than in 1875. The past winter was quite mild, and few services were frozen, while the maximum demand occurred in the month of July. The daily supply per inhabitant was 101.8 gallons, which, although 5.8 gallons less than in the previous year, is still enormous. The maximum amount pumped in one day was on the 15th of July, 13,540,800, gallons over 3,000,000 gallons less than the maximum of the previous year, which occurred during the cold spell. The mean quantity pumped for the year was 11,107,499 gallons, or 3.7 per cent. less than in 1875, but 23.2 per cent. greater than for 1874.

A table showing the number of gallons distributed in the several years from 1852 to 1876 inclusive is given, from which we extract the last ten years.

Year.	*Gallons of water pumped.*	*Average daily delivered.*	*Galls. of water for one cent cost of fuel.*
1867..	1,425,535,230	3,905,576	1,408 37
1868..	1,666,545,125	4,507,248	1,464 55
1869..	1,646,810,325	4,511,°09	1,464 10
1870..	1,866,060,068	5,112,493	1,467 74
1871..	2,300,150,605	6,301,782	1,567 42
1872..	2,782,292,578	7,601,892	1,453 64
1873..	3,193,393,948	8,762,723	1,580 76
1874..	3,289,872,635	9,013,350	1,610 18
1875..	4,207,454,260	11,527,272	1,966 73
1876..	4,065,334,470	11,107,499	2,049 79

This table also shows careful water takers that they not only have to pay for all they consume themselves, but also for what their neighbors waste. The cost of pumping each million of gallons has been $7.33; or taking the average lift at ninety feet, of raising the same 100 feet high, $8.16.

THE new manual and price list of Engineers' and Surveyors' Instruments, issued by Buff and Berger, of Boston, a copy of which we have recently received, is a well arranged and instructive pamphlet. The part upon Instruments and their Adjustments especially contains valuable matter for all who use the transit, level, etc.

In answer to a correspondent, the New Orleans *Times* makes the following statement, which, upon the authority of Mr. E. L. Corthell, is correct:

The depth of water through the jetties, upon the statement of Captain Barrett, of the Plymouth, is 24 feet. The captain made soundings from the Plymouth while passing through, and announced that as the least depth found. He did not state how close he made soundings. They were probably one hundred or more feet apart. It is well known that the scouring action of the water confined to the space between the jetties leaves the bed in a very irregular and knotty shape, therefore the Plymouth may have passed over plac s of less depth than 24 feet, and very probably did—for it is known that the main obstruction to deep water is now confined to a very limited space, viz: to the outer bar, and this seems to be very tenacious, and is scoured out very irregularly. The main delay and difficulty at this point is directly traced to the insufficient confinement and direction of the water, over one-third of which flows or is wasted over the jetties. All this water should be forced through them, and compelled to cut or scour out the bar. The Jetty Company being now flush, it will undoubtedly take steps to build up and complete the jetties.

Their success in securing deep water has been sufficiently demonstrated by the results already obtained. The absolute finality of their endeavors is only a matter of time, of course. It should be remembered that no one having the authority, or connected with the Jetty Company has ever yet asserted that there was a greater depth than 21 feet through these works. Col. Andrews, in giving his notice "to all interested parties," only stated that there was a 20 foot channel through—with a somewhat deeper channel through the shoal at the head of the passes. "Roundabout" understands that Col. Andrews now only claims a clear channel of 21 feet through the outer bar, although asserting his ability to put through a 22 feet steamer at high tide Now, can any one deny that there is a channel of 20 feet, for a government survey has established that fact.

With regard to the passage of steamers to and fro through the jetties, this is more owing to the whims and pleasure of the pilots that give them direction, than it is to the depth of water. It is quite well known that these men have been bitterly opposed to the jetties, have continually scouted their success, and are still loth to admit it. Nothing would delight them more than that they should prove a failure, as their interests are decidedly opposed to an open passage to the sea. Hence it is not unreasonable to suppose that they will use Southwest Pass as long as they can. "Roundabout" can assert positively that no vessel whatever has suffered the least obstruction or delay in passing through the jetties since they were authoritatively opened. Had this been the case, there might be some reason for doubting the results published

In regard to the ship Belle O'Brien, "Roundabout" has learned that the choice made by her captain, of the Southwest Pass, in preference to the South Pass, signified nothing more than that he knew he could get out all right that way and was ignorant of the other route. If some newspaper writer had stated without authority that the ship was en route for India, and she really went to Cork it would be about as reasonable to consider it a reflection on India, as to attribute her choice of Southwest Pass to the fact that the jetties were impassable. If she did not use the channel between the jetties, she might have done so. Her captain had a preference and he exercised the right; that was all. In regard to the steamship Mississippi, her agent informed Roundabout that the reason why she went round to Southwest Pass to get her coal was because it was to be had there. If she had taken in coal in the city she would have drawn more water than was officially announced as to be had through the jetties, not less; and, therefore, she went down without it. The coal depot being at Southwest Pass, she had to go there for it after having passed through the jetties. The statement that the Plymouth drew 19 feet when she passed up might have been an error. Possibly she only drew 17 feet, But if an error was made it was not the fault of the jetties. Her captain found at least 24 feet all through wherever he sounded. Finally, "Roundabout" will inform his correspondent that the grand object of the jetties was not to shorten the distance to Europe, but to get deep water over the bar, so that vessels of a greater draught could pass in and out unimpeded. When they were commenced—not two years ago—there was scant 8 feet over the South Pass bar. Now the world is officially informed that there is 20 feet. One would suppose that this should prove satisfactory, but still there are grumblers because there is not a still greater depth. To all such "Roundabout" would recommend patience. The same power which scoured out the first 12 feet is still at work, and may be relied upon to labor as effectively as ever.

The Milwaukee avenue viaduct, crossing from different railways at an elevation of about 40 ft., is about completed. Like many other necessary improvements, this work was contemplated for a long time before any active steps were taken to carry it out. Finally, in the spring of 1876, an appropriation of $68,165 was make for the abutments and approaches, and one of $40,000 for raising the houses on the approaches and other incidental expenses, the railroads agreeing to build the viaduct proper, except for a part between Carrol street and an alley, which the city was to erect. The work was done under the superintendence of Mr. George Wilson, Superintendent of treets and Bridges, Mr. O. C. Cheney having charge of the superstructure. The contract for the masonry of the approaches, the pile-work, and paving was awarded on the 24th of March to Mr. James Kincade, and work commenced shortly thereafter. The contract for masonry was let by the cord, for piling by the lineal foot, and for lumber by the 1000 feet. In the substructure there were used 62,700 cubic yards of filling, 7,255 yards of paving, and 2,593 cords of stone in the city's portion. The abutments of the railroad bridge took up 423 cords of stone, which is charged to the different companies. In addition to all this the city used 4,320 lineal feet of piling and 11,000 feet of pine lumber.

The contracts for the iron work of the viaduct proper were let in July, but, owing to some delay on the part of the railroads, were not signed until September last. For the southern part of the viaduct, that over the Milwaukee & St. Paul and the Danville & Vincennes Railroads, both on Milwaukee avenue and Desplaines street, the contract was let to the American Bridge Company of Chicago, for $35,320.15. Thomas Leighton, of Rochester, N. Y., received the contract for the northern half, which crosses the Chicago & Northwestern Railroad on both streets, forming a Y, and the price fixed was 34,690. This part of the work completed nearly a month ago except for the paving and sidewalks, which are now almost finished. All the plans of the iron work were drawn in the Superintendent's office, Mr. S. G. Artingstall designing the viaduct. This weighs from 500 to 600 tons, and extends 476 feet on Desplaines street, and 674 feet on Milwaukee avenue, though from this measurement must be deducted the 125 feet of the pile bridging on the former, and 176 feet on the latter thoroughfare which separates the two halves of the work. The south half is what is known as a three-span truss, and the north half a plate girder bridge. On Milwaukee avenue the approaches are about 1,200 feet in length, on Desplaines street about 800 feet. The slope is very slight,—only 1 foot in 50 on the main thoroughfare, and about 1 in 40 on Desplaines street. Besides these, it became necessary to make approaches east and west on Kinzie street, extending 320 feet in each direction.

It will thus be seen that the job was one of considerable magnitude,—in fact, the largest of the kind yet attempted in Chicago. There was some hindrance from frost but not much, and the expense is expected to fall within the appropriation, except in the cases of damage claimed by persons owning property along the line. The total expense of raising the houses, many of which are large structures, is estimated at $70,000, though this is not exact, some claims being yet unsettled. The entire cost of the work is $135,000.

The "American Society of Civil Engineers" held their regular monthly business meeting for March, in their rooms at No. 4 East Twenty-Third street, New York, on Wednesday evening of the 7th inst., beginning at 8 o'clock.

After the reading of the minutes of the meetings for February, by Mr. Leverich, the Secretary, a paper by Mr. J. F. Flagg was read on the "Formation of Levees" for the protection of the banks of rivers against the abrading action of the water, proving that such protection was sufficient to prevent the washing away of the embankments.

After the reading of the paper, a long discussion was held by the members on business pertaining to the society. Professor R. H. Thurston then gave a very interesting account of the labors of the Government Commission appointed for making tests of American metals and of which he is a member. He described how the Commission was divided into different committees, the duties of each and the amount of work which they have accomplished, showing that many interesting and valuable results have already been obtained relating to the properties of American metals, as well as how much more could be still accomplished if Congress would only consent to the further existence of the Commission. The Senate warmly supports the Commission. The opposition comes only from the House and is probably awakened by the false fears of manufacturers who think that, in the reports to be made of the grade of metals, theirs *may be* reported as being of inferior quality, thus damaging their business. In reality, though, the names of no manufacturers are to be published as furnishing either good or poor metal. The object of the Commission is to furnish a report of the strength and properties of American metal in comparison to those of foreign, showing the equal goodness if not superiority of our manufactures, besides obtaining more accurate and general knowledge of the properties of metal subject to every possible condition.

As yet but a small part of this projected work has been accomplished, and, unless the scruples of the House and the fears of manufacturers are overcome, the Commission must dissolve without fulfilling this important work.

At the conclusion of the remarks of the speaker, which were listened to with great interest by the members of the society, the meeting was adjourned.

There are three practical considerations that influence the placing of windows in any building. These are,—their use in lighting and ventilating the building, constructive convenience, and architectural effect. They are all legitimate and important considerations, in their due order, in which of course the first is the chief. He takes a foolish part who essays to determine a question of windows without regard to them all; but there are limits within which each may reaonably yield to the other. In rooms which are to be used as sitting-rooms or living-rooms, especially where there is any view to be seen, it is a crying fault to set windows so high that people in their chairs cannot look out of them with comfort. But in places set apart for special services, as churches, or where any occupation which requires concentrated attention is to be carried on, the case is quite different. In a room that is to be used only for study and writing, the important requisites are that there shall be plenty of light, and it shall come from the proper quarter, preferably from the left hand, and that it shall not be too low. These considerations secured, we should be inclined to say that between three feet and five, the latter was, on the whole, the better heights for the window-sills in a schoolroom. The light that comes in below that level is not serviceable, and there is no reason for tempting either teachers or scholars to turn their attention out of doors. The limit, however, is one within which architectural effect may reasonably be allowed to rule. One would naturally infer that this was the determining consideration in the schoolhouse referred to. But whatever may have been the real justification of the singular resolution we have quoted, the reason given for it in the preamble is as apposite as if it had been recommended that whereas the ten chimneys on the Town Hall, serving twenty-five fireplaces, rose only twelve feet above the roof, while the six chimneys on the Court House, serving only eighteen fireplaces, rose fifteen feet above its roof, therefore the six chimneys should be razeed to the height of the ten.—*American Architect and Building News.*

CORRESPONDENCE.

NEWPORT, KY., *March 12, 1877.*

Editor ENGINEERING NEWS:

SIR.—I beg leave to submit the following method of keeping level notes which I believe to be better than any that has yet been presented through your paper:

Sta.	B. S. and Height of Instrument.	F. S.	Diff.	Elevations.	Remarks.
B. M.	2.619 108.906			106.287	
24		3.2		105.7	
25		5.1		103.8	
26		4.8		104.1	
	0.364				
Peg.	101.575	7.695	—4.076	101.211	
27		8.8		92.8	
28		10.2		91.4	
+50		9.9		91.7	
	10.298				
Peg.	102.000	9.873	—9.509	91.702	
29		4.6		97.4	
30		6.3		95.7	
	5.198				
Peg.	97.961	9.237	+1.061	92.763	
+40		3.1		94.8	

Space is economized by placing back (or plus) sights and height of instrument in the same column. The height of each turning point or peg is at once checked by differences as shown. Intermediate elevations can be carried out as the sights are taken, or at convenience.

By using a plain rod with figures one-tenth of a foot in height, and the same distance apart (by figuring only alternate tenths), the leveler can read to hundredths, and thus have a check on the rodman's "call" of the sight on turning points. Besides, as it is not necessary to change the position of the target for intermediates (as it is with the slide rod) the leveler can and should verify the call by reading the rod himself when the rodman comes up, or when he moves ahead, as the case may be.

Slide rods are an abomination, from the fact that the leveler is at the mercy of his rodman, who may make any number of mistakes in reading, and there is no check on him. Another fault is, that nearly as much time is consumed on intermediate sights as on turning points. With a plain rod, however, numbered as described, the leveler can catch each intermediate as the rod is plumbed, reading to the nearest tenth (and anything closer is useless for ordinary work) and no time is lost.

B. R. MORTON.

[*Written for Engineering News.*]

CEMENTS AND CONCRETE.

BY BERNARD R. GREEN, C. E., PORTLAND, ME.

(*Concluded from page 61.*)

Under ordinary circumstances two men will be required at the mixer, one at the engine, one at hoisting machinery, when used, and six for preparing charges. The force of men or mechanical arrangements for bringing up materials and conveying the concrete to the work will of course vary largely with the relative location of, and communication between the different points.

The charge for this mixer should not exceed, usually a cubic yard, because, if too large, the mixing will be retarded and will require, moreover, a considerable increase of power. The size of charges and the rapidity

of succession, up to 150 cubic yards in ten hours, are limited only by the force and facilities for charging, transporting and depositing in the work, activity of the cement, etc. Eight revolutions in about one minute, for charges of about three-fourths of a yard, is a good working speed; this does not include charging and discharging. A higher speed defeats the object by generating too great centrifugal force in the contents, while too much mixing tends to give heavy stone ballast an undesirable polish, besides needlessly wearing the machinery.

The remarkable mixing action of this machine was shown by reducing the number of revolutions until it was found that even one-and-a half turns sufficed to mix ingredients, thrown in at random in due proportions for concrete, so far as to well moisten each particle. Owing to its grinding effect with coarse ballast, no auxiliary mortar mill is required. A four to six horse-power steam engine easily runs it with ordinary charges. If the reader will rotate a cubical block or box around its diagonal, he will perceive its peculiar adaptation to a stirring and mixing process.

In charging, the materials for a batch are thrown into the mixer at random the cement, sand and water having been previously rudely stirred together.

The mixed concrete should be speedily conveyed to its destination, to avoid partial setting or drying under a hot sun, and it should, if possible, arrive at such an elevation that, in dumping, it will not fall or slide more than two feet. In former years it was a common practice to throw concrete from a height of ten or twenty feet, but the expected gain of compactness by this method must have been more than balanced by the inevitable loss of uniformity in the mass caused by a separation of the coarser ballast.

When dumped in place the batch is at once spread, (preserving the mixture of coarse and fine ingredients), in a layer of such thickness that the ramming, to follow immediately, will reduce it to from 4 to 5 inches, varying with the quality of the work and the coarseness of the ballast; 6 inches being the common thickness. Four to six men rapidly and evenly ram each layer, by means of iron or iron-shod upright rammers, about 4 inches square on the face, and weighing about 25 pounds. The ramming should be performed by light, quick blows, to avoid shattering the ballast of the new, or cracking the lower layer.

At this point the practised eye detects any serious error in the proportion of water. A jelly-like consistency should ordinarily not be allowed. With Rosendale cement the amount of water should be such that a thin film is raised upon the surface of each layer only by a thorough ramming, which should then cease; but with Portland cement, carrying less water and therefore quite incoherent, more ramming is essential and it should continue until the layer is perfectly compact and unyielding.

As the work thus progresses it should be so managed that the successive layers shall be least exposed, while soft, to the drying action of the sun and air, the damaging effect of a shower of rain, or a frosty night.

A due regard for economy calls, of course, for such an harmonious arrangement of the force and appliancies, employed in the several steps of the process, that all will be in constant and steady motion.

A concrete with ballast of round particles can be more easily reduced to its smallest compass by ramming, than one composed of rough, angular or flat stones. Portland cement will bear much more sand and ballast than Rosendale. Good concrete with Portland cement may consist of cement 1, sand 4 pebbles 8, and stone 10 parts, by bulk; but a common and better mixture is, cement 1, sand 3 to 3½, pebbles 6 and stone 8 parts, making fully 1½ cubic yards of rammed concrete per barrel of cement. In England concrete is said to be commonly composed of 10 parts sandy gravel, and sometimes of 4 parts sand, and 16 of stone, to 1 part of Portland cement. A very good concrete with Rosendale cement is composed of cement 1, sand 3 and mixed stone 6 parts, making 21¾ cubic feet per barrel of cement, when rammed.

Careless measuring of materials should be carefully guarded against, and a struck measure or its equivalent invariably insisted upon for them all. The absurd practice of using the shovel, or otherwise relying on shrewd guessing in this matter, has often been the unsuspected cause of failure, more or less serious.

A block of good ordinary Portland cement concrete, containing cement, sand, pebbles and stone, in proportions of 1, 3, 6, and 8, respectively, and measuring 5½ in. × 3½ in. in section and 3 in. in height, should bear, when ten days old, a crushing weight of 2½ to 3 tons. A block of Rosendale cement concrete, measuring 8 in. × 3½ in. and 3 in. in height, and composed of the four materials in proportions of 1, 2, 4, and 4, should sustain 3 or 4 tons, at the same age. It is obvious that such small test blocks should not contain large fragments of stone.

The strength of concrete depends upon the cohesion of the matrix, its adhesion to the aggregates, the irregular bonding or interlocking of the coarser fragments, and, as before stated, upon the strength and proportion of each ingredient.

Temporary cribwork, plank facings, etc., built to confine or give external form to the work, should possess sufficient rigidity to prevent the ramming of a new layer from disturbing the edge of the previous one by the bulging of the boards, and also, if desirable, to give the work a true face. The pressure caused by ramming will badly spring a 2-inch pine plank unless securely supported at intervals not exceeding 3½ or 4 feet.

When concrete is too coarse to form against the mould a sufficiently smooth surface, the difficulty may be overcome by thinly coating the mould, or plank facing, with a mortar of the same composition as that in the concrete. If such mortar be too rich in cement it will be liable to flake off in time from the action of heat and cold.

In conducting a work in concrete, extending over many days, where the intervention of night or a period of unfavorable weather, may compel a suspension of work, the last surface, on which the next layers of concrete are to follow, should be left as nearly as possible normal to the force the work is designed to resist; as would be the case in good stone masonry; that is, normal to the soffit of an arch, inclined in a leaning or retaining wall, level in a vertical wall, etc. It is sometimes advisable to place every fresh layer of the concrete approximately in such a position. The need of the first mentioned precaution arises from the weakness of adhesion of new to old work, the joints becoming planes of least resistance. Adhesion in this case is increased by moistening the old surface and applying a thin coat of mortar to it as the new layers approach.

Artificial stones of forms and dimensions adapted to almost any position occupied by ordinary building stones, may be made of Portland cement concrete, in wooden or metallic moulds, on the work close by or in their final places, or at a distance.

The *beton agglomere* of M. Coignet, of Paris, is, without doubt, the nearest approach yet made to a perfect concrete. The main features of Coignet's system are, briefly: the use of the best limes or cements, preferably Portland cement; the least quantity of water that will serve to thinly coat each particle of sand with the matrix; large doses of sand and gravel nicely proportioned to produce the most compact mass; thorough and prolonged trituration by machinery; and finally a perfect systematic ramming in thin layers in the work.

In France and elsewhere, many very bold structures have been executed in *beton agglomere*, which demonstrated its superiority to common concrete. Years ago in the infancy of concrete making in this country, General Totten so far apprehended the true method, as developed by Coignet, as to insist that so much of it should be followed, on the government works, as was then practicable without the Portland cement and improved machinery of to day. Concrete should be a close imitation of *beton agglomere*; but this will be impossible, as to the ramming, in submarine works in contact with water, owing to the necessity of omitting this very essential operation.

Coignet's system has been fully reported upon by General Gillmore, whose book gives much valuable information on the general subject, in a condensed form.

Thus it is plain that the extensive and extending use of concrete, even beyond the usual capabilities of masonry, offers a wide scope for the exercise of ingenuity guided by scientific principles, and also that the materials and facilities available, accessibility of the work and of its often difficult parts, trustiness of workmen, and other items not to be forgotten in an estimate, operate to modify, more or less, the mode of execution and the cost of concrete work. In ordinary constructions of magnitude, say a few hundred cubic yards, the cost, in the eastern states, ranges from $5.00 to $10.00 per yard, $7.00 being perhaps more common.

Important work in concrete should never be entrusted to ignorant or doubtful hands. Imperfections may be so easily covered up that occasional inspection would be of no avail, in such cases, to prevent future failure, especially in submarine or hydraulic works. Untiring, faithful supervision is indispensable to success, while, under it, excellent work may be accomplished by the most ignorant laborers.

When a more extensive introduction of concrete shall be made in every-day building operations, a class of men skilled in the principal manipulations, may spring up and the trade of the "concrete mason" be generally recognized.

It is seen that mortars and concretes are adapted to any structure from a statuette to the grandest edifice, their general adoption being only a question of cost. Concrete house-building is not uncommon in Europe, and many examples exist in this country, while the constantly widening use of cement in drain pipes, sewers, fire proof floors and partitions, and cellars, excluding both moisture and rats, is well known. Students of the problem of street pavements suspect great value in Portland cement concrete or *beton agglomere*, in that direction, experiments having already been very successful.

A common, though too often careless and foolish use of hydraulic cement, is in the form called "grout," which consists of cement and water of the consistency of cream. Sand is sometimes stirred in when the grout is thick enough to hold it a short time in suspension. Coarse or fine ground cement answers equally well. Grout can never attain the density of good mortar and is only useful for filling joints, cavities or interstices inaccessible to mortar. A valuable application of Portland cement grout has been made by injection under a hydrostatic pressure of a few feet, into confined masses of pebbles and broken stone, where it has set firmly and made an excellent concrete. The practice is not advisable where good mortar can be properly substituted.

In concrete work, as in many things, experience and good judgment in making the most of circumstances and available materials, are essential prerequisites of success, for good concrete may often be brought out of very bad materials judiciously handled. The growing knowledge of the subject promises in future fewer instances of a lavish use of concrete to ensure safety from the results of defective manipulation.

The indifference with which this subject has been regarded in past years by the majority of engineers, even those who have made much concrete, is surprising. Whether the mysterious chemical actions involved appeared a discouraging field of study, or whether the fact that good lime accompanied by moisture would stick to a brick or stone, was considered sufficient, is not apparent, doubtless both lent their weight.

It is certainly not to be expected that every busy engineer shall acquaint himself with the details of innumerable experiments and chemical analyses, but he may acquire such knowledge as to be able to assist in enlarging the utility of concrete, as opportunities offer.

AMERICAN SCIENTIFIC AND TECHNICAL JOURNALS.

The great improvement in our American Society and periodical publications, manifested by comparison with similar papers issued ten or twenty years since, can be accepted as the best of evidence of national advance. After taking a general departure from the *elementary* physics, chemistry, mechanics, or decorative or constructive art, the paths have diverged widely in the multiplicity of ways of applied science, and are followed by parties of enthusiastic searchers for novelties or knowlekge, each party in the direction of an especial subject of interest, profit or study.

The tendency is to establish separate bodies of society organizations, which seek for members all over the land to obtain that appreciative corps of readers and those audiences which stimulate competition, and give zest to the production of the dryest of documents. The general scientific society, either national or local, must divide into sections to obtain interesting or intelligent discussion or investigation. General science, alone and of itself, without particular application, it is recognized, is merely childish—the term implies a superficiality incompatible with progress. Our American societies have, therefore, become special and national and the result has produced a series of society publications during the last ten years quite equal in importance to those which have been printed in any foreign land of the same population. We are a little apt to associate scientific publications solely with those bodies which are called professional; but the race of knowledge is now open to all avocations, and with the mechanical growth of the last century all industrial pursuits have become scientific. It is only within fifty years that chemistry was admitted to form part of a collegiate education. And none of the professions or pursuits which we now call "technical," have the sanction of antiquity as scientific. To-day, however, it is in the papers of the Society of Civil Engineers, the Institute of Mining Engineers, the Institute of Architects, the National Association of Wool Manufacturers, the Railway Master Mechanics' Association, of Master Car Builders, and numerous other associations of similar avocations, that we must look for the highest and most valuable contributions to technical science. The yearly or occasional publications of these societies are replete with novelties and matters of information.

Beside these permanent records, or American technical news journals most weekly issues, contain not only a supplementary mass of purely technical knowledge, which has been elevated by the influence of the societies to a corresponding standard of excellence, but these journals are also made to be the translators of the language of the avocation which they represent, to the comprehension and instruction of that portion of the public which has to do in business, or any other way, with the particular subject. The list of these periodicals is extended and extending. Their relative circulation and popularity, other things being equal as to merits or display, of course depend on the general usefulness of, or sympathy with, their objects. Thus a paper like the *Architect and Builder*, profusely illustrated and carefully edited, will address itself not only to the professional architects, but also to all of that numerous class who build or wish to build houses, and those who take interest in church or other public buildings. There are none, from the highest to the lowest in the community, who are not interested in buildings. Chemistry, or mining, or railway engineering may not command so many readers, even if the illustrating and editing are equally well accomplished; while other papers will only find a limited and restricted circulation and sale, with the small community of interested people, they address. Patent inventions and novelties in mechanism are objects of absorbing concern to a portion of the community, and are represented by journals of rival, and on the whole, increasing merits. The more abstruse avocations, chemistry, telegraphy, photography, etc., find expression in periodicals of the highest literary attainment, and inform and gratify respective microcosms of specialists, in unknown tongues, incomprehensible to the outer barbarian. Even the minor trades become scientific and literary, and the *Lumberman*, the *Carpet Trade*, the *Tobacco Plant* add to the stores of human knowledge, until "the ample page" can be no more unfolded, and the "spoils of time" will be lost in the waste basket, or at best, on the old book shelf.

Even the advertisements, in their descriptions and illustrations of apparatus and machinery, form no small nor unimportant part of the information, to be now and hereafter accepted as philosophical and scientific. The free use of the pencil, through the various modes of "illustration" in the current newspapers, becomes a perpetual international exhibition of the latest proposals, as well as of the established practice of mechanism in all branches of trade or manufacture. It has been a popular misconception that the scientific man was to teach the workman—the skilled artificer—the practical manufacturer. The truth is that the record has always until now been behind the accomplishment. The use and value of such record is in the perpetuation of the accomplishment as the starting point of effort by the next person who undertakes to perform the same or a similar task. But now it almost seems as if the record itself will be lost as soon as made in the multiplicity of papers and documents. It will be as finding one's route in a railway guide, to trace out any specific object from the maze of literature.

Not the least valuable or important of our scientific publications are the trades' circular books of some of the larger manufacturing establishments. One could be instanced giving the early history of the locomotive in America; another gives all the details of heating apparatus construction; while the various *tool* circulars unfold the mystery of workmanship more thoroughly than any text book of science can pretend to. All these together register the advance of year by year with ineffaceable marks—aggregately they are building up the edifice of science, and the American press of to-day is supporting with great and noteworthy ability, the growth of civilization in our country.—*Journal of the Franklin Institute for March.*

THE WEST SIDE PUMPING ENGINES.

The Chicago papers give us glimpses of an interesting and instructive dilemma in the matter of the new West Side pumping engines in that city. It is worth while to tell the story in outline from the beginning, since it illustrates a new phase in the subject of high-duty engines—a subject which has been in other aspects and with reference to special instances of practice, pretty thoroughly considered in our columns already, particularly in the acute reviews of "duty-trials" furnished by our esteemed correspondent, Mr. Theron Skeel.

In July, 1874, the Chicago Board of Public Works advertised for proposals for two pumping-engines. The gentlemen composing the Board have since retired, as we are informed, to private life, without that degree of applause from their fellow citizens which could fairly be interpreted as an "encore." But the results of their remarkable advertisement cannot be retired so easily. That document appears to have been drawn on the hypothesis that the more one required of a contractor, the more margin one would have for allowing him to fall short; or else, that in order to get superhuman results it was only necessary to make superhuman demands; or else, that Chicago being fairly entitled, was also fully able, to get by asking, the most extraordinary machine in the world; or, finally, that by setting up conditions under which the most practical manufacturers would not dare to bid, the perplexity of choice among numerous competitors would be greatly simplified; On the last supposition, the Board deserves credit for its efficient method of weeding out bidders beforehand.

The specifications called for engines, each capable of raising 15,000,000 gallons 155 feet in 24 hours, and the two ocupying not more than 50 by 30 feet on the floor of the engine house. Two boilers must be sufficient to supply all the steam required, though three were to be provided. The engines were to run continuously, day and night, seven days in the week, to be operated for one year by the contractor, and at any time during that year to be submitted to a duty-test of six consecutive days of 24 hours each, in which test they were required to perform the duty of 90,000,000 pounds of water raised one foot high with one hundred pounds of Pennsylvania anthracite, no deductions being made for ashes or clinkers. There are some other rigid requirements in the specifications, but we need not enumerate them. Engineers will readily admit that a machine capable of coming up to the tests above set forth, would probably meet all the rest.

The limitation of the boilers to two in number, for engines of 850 combined horse-power, which according to Cornish rules of high practice, would require something like 25,000 square feet of heating surface, and for which ordinary prudence in high practice dictates at least 15,000 feet, and the restriction of the engines in size, and points which look intimidating to most builders. But the "duty" requirement casts everything else into the shade. Here are engineers disputing whether a 90,000,000 duty was ever really reached in this country, on short trials, under favorable circumstances. "Where," says the skeptics, "after full preparation, with clean fires and selected fuel, has this duty been achieved?" If they are pointed to Lynn, Mass., they reply by appealing to the *Engineering and Mining Journal* of March 11, 1876, in which the Lynn engine and its performances are overhauled. If they are referred to Lowell, they quote (in the absence of full publications on the subject) the admission of the inspecting experts that the results at Lowell are in practical conformity with those at Lynn. And after Mr. Skeel's searching analysis of the tests at Lawrence, nobody will appeal to Lawrence.

But the Chicago Board of Works required that this feat, which probably no American engine, in its most inspired moments, had ever achieved, must be performed by the West Side engines *for six days running, taken without notice at any time during a year of continuous operation, and that the amount of duty should be reckoned on the ashes as well as the coal.*

"But a beaver can't climb a tree," interrupted the listener to a somewhat highly-colored narrative of animal adventure. "Can't climb a tree? I tell you he *had* to climb a tree; the dog pressed him so hard!" Was this the spirit in which the Chicago Board prepared to raise to unprecedented heights the standard of American machinery?

Whether such was their intention or not the effect was to bull-doze the constructors of steam-engines. Many persons who thought they would be held to the rigorous requirement of these specifications, and would have to remove their engines and repay all moneys received if the 90,000,000 duty was not forthcoming, sadly but honestly refrained from bidding. But parties were found to attempt the impossible, and the contract was given to a builder who had constructed other engines for the same city previously—in fact all the waterworks engines, we believe, which the city has had. No one of these engines, however, had ever accomplished more than a low average duty. The last pair, only a few months before the giving of this contract, had been examined for the Citizens' Association by a committee, which in answer to the question of the economy of the engines, reported—"The work is not accomplished with a fair degree of economy." Perhaps it is natural that one who had never come within hailing distance of a 90-million duty should underrate the difficulty of reaching it—like the man who presumed he could fiddle, but had never tried. If the builder of the engines realized what he undertook, it is hard to resist the conviction that he must have known he would fail, and that he must have relied on the numerous precedents going to show that cities would rather accept waterworks that do not fulfill their contracts, than have a great trouble and confusion and begin all over again.

The famous duty-test has been made, and the engines give between 74 and 77 million foot-pounds instead of 90 million. But they are well built, run smoothly, and fulfill the requirements of capacity; and if the old Board were in power, we do not doubt that they would be accepted. The disposition on the part of the new administration to traverse and undo the work of their disparaged predecessors may lead to a strict construction of the contract. But we do not anticipate that the West Side people will see the engines removed, as the contract requires, and their half of the city left for a couple of years longer in danger and discomfort. A Chicago paper says: "there are two things to be done: accept the engines as they are and may prove to be, or endanger the property and disturb the peace of a large number of the inhabitants of this city."

There is another possible alternative, which seems to us the best thing now practicable—namely, a compromise, for which the price of the engines under the contract is said to leave sufficient room, without injustice to the builder.

Certainly it seems severe to exact full penalties of a man who has done his best, and furnished, according to all accounts, excellent engines, merely because he has not performed what was universally deemed impossible, and certainly known to be unprecedented. But on the other hand, why should the impossible have been required, and being required, why should it have been undertaken? We are willing to believe the engineer of the Water Board desired in good faith to obtain by rigorous specifications the highest efficiency; but we must nevertheless blame him (if it was he who took this responsibility) for setting his mark so high as to exclude reasonable competition. Without assailing the motives of the Water Board, we must observe that a Board *could*, under such circumstances, make use of the excessive scientific enthusiasm of its engineer to put the work into the hands of some favored party who had the courage to promise what he could not perform. A Water Board *could*, under such circumstances, that give private assurances to the favored party that his work would be accepted somehow, though it should not reach the standard nominally set up. Thus it is evident that absurdly high requirements, however well meant, practically render the whole contract system nugatory by "bull-dozing" honest contractors, and then "counting in" imperfect returns.

Some of our best engine-builders refuse to be bound by the notion of economy involved in the results of "duty trials," and undertake only to furnish machinery at a certain price to do a certain work with reasonable economy of fuel. While this extreme may be practicable to builders of established reputation only, it is evident that in competitions where the promises, not the reputation of bidders are to be the grounds of preference, the requirements should be reasonable, in order that the construction of the terms of contract may be strict and relentless. To make the requirements of cast-iron and the subsequent interpretation of india-rubber, is to convert the system of open competition into a bull-dozing business, which is certainly a farce, and might easily become a fraud.—*Engineering and Mining Journal.*

DEAN BROS., of Indianapolis, Ind., will furnish the pumps for the city of Peoria, Ill.

SPECIFICATIONS.

FOR CONTINUING THE WORK ON THE IMPROVEMENT OF THE SAGINAW RIVER, MICHIGAN.

The work contemplated is the construction of 1 000 feet, more or less, of pile revetment, according to the designs furnished by the United States Engineer officer in charge. Also such dredging in connection with the driving of the piles, and in deepening the channels as may be required by the Engineer officer in charge.

Piles.—To be in kind as shown in the bill of materials herewith, straight, sound, and of live timber; in size one (1) foot in diameter midway between the ends; in length sufficient to comply with the requirements for driving as hereafter stated; to be squarely butted and with a point in the axis of the pile made by four flat faces, each not less than four (4) feet in length, the opposite faces converging to within four (4) inches, beyond which a blunt point with four (4) equal faces, is made on the tip of the pile, the pil s to be pee'ed for a distance not less than twelve (12) feet from the butt.

Timber.—To be straight, free from windrot, shakes, wane and other imperfections, and furnished in kinds and dimensions as shown in the bill of materials.

Slabs or Edgings used for filling to be furnished in pieces not less than twelve (12) feet long, except for filling the superstructure where the lengths of the pieces will correspond to the distance between the sets of ties.

Stone.—The minimum size of which is taken at nine (9) inches cube, or an equivalent thereto, to be in specific gravity and hardness, suitable for ballast.

Iron.—Bolts and washers to be of best quality of American wrought iron, and to conform in dimensions to the bill of materials.

No material will be accepted until it is actually in the work.

All materials to be subject to a rigid inspection by an agent appointed on the part of the United States, and such as do not conform to the specifications under which they are offered, to be rejected.

Driving Piles.—Two parallel rows of piling will be driven, the front or channel row at a distance of twenty (20) inches apart, the back row to be at a distance of thirteen (13) feet from front row, measuring from center to center, to be driven seven (7) feet three (3) inches apart from center to center, and in a direction to be determined by the Engineer officer or agent in charge. Each pile to be banded for driving and driven until its point is at least ten (10) feet below the bed of the channel opposite, and at least twenty (20) feet below the surface of the water (mean low water), and in addition each pile to be driven until it will not move one (1) inch from a force equal to eight (8) consecutive blows of a hammer weighing two thousand (2,000) pounds, and falling twenty (20) feet.

Framing Piles.—All piles to be cut off in a horizontal plane ten (10) feet above mean low water, and each pile in the outer row scored down on the outer face, so as to give a bearing against which the waling may rest, the inner face of each pile in the outer row to be slightly scored, to give a fair bearing to the binder. In all cases at least nine (9) inches of the pile between the waling and binder must remain.

Framing, Waling and Binder.—The waling and binder of pine to be put on, so as to break joints with each other, and to be held in place by a screw-bolt through every third pile. The upper surface of the waling to be two (2) feet below the top of piles. Pieces to be joined with a twenty (20) inch lap joint.

Framing Superstructure.—The superstructure, fourteen (14) feet in width, is to consist of two courses of pine timber, the first of which is laid upon the tops of the piles. Ties at intervals of eight (8) feet from center to center in length of pier, to be framed and placed as shown in tracings. All gains are to be cut six (6) inches deep, twelve (12) inches wide on the outside, and eight (8) inches wide on the inside of pier to receive dovetailed ties. Such gains to be cut on the upper side of the first, and lower side of the second course. Timbers in the consecutive courses not to break joints between the same sets of ties, and the end of no timber to approach a tie nearer than two (2) feet. The first course of timber on the back row to be joined together with a twelve (12) inch lap joint, the joint to come on the top of a pile.

Bolting.—The system of bolting to be as shown in tracings. Holes for drift bolts to be bored with an auger not to exceed seven-eights (⅞) of an inch in diameter for the entire length of the bolt to be driven. Holes for screw-bolts to be bored with an auger not to exceed one and a quarter (1¼) inches in diameter.

Filling.—Slabs and edgings used for filling to be carefully placed, the lengths in the direction of the pier, and a top-dressing of stone two (2) feet deep used to secure and settle the filling.

Dredging.—Such dredging shall be required in connection with the driving of the piles, and in deepening the channel, as may be considered necessary by the Engineer in charge of the work. The material shall be properly dumped on the bank of the river immediately below the improvement.

Approximate amount of materials to be furnished and labor performed under the present appropriation.

Pine timber framed and put in place, 80,000 feet b. m. Oak or Norway pine piles, and driving, 14,143 lineal feet. Drift-bolts, screw-bolts and washers in place,. 13,020 pounds. Slabs in place, 2,067 cords. Stone in place, 190 cords. Dredging, 3,000 cubic yds.

G. WEITZEL, *Major of Engineers.*

BUSINESS PROSPECTS OF 1877.

Many engineers have been earnestly scrutinizing the signs of the times, to see if the future offered any brighter prospects. The cessation of railroad construction in 1873 threw numbers out of employment, and the depressed state of business soon brought to a close most of the works of construction; engineering as a profession has of late been a poor means of gaining a livelihood, although probably no worse than many other occupations. When trade is brisk people are enterprising, and capitalists are on the lookout for investments; undertakings are set on foot, public and private improvements inaugurated, which call for the services of the engineer to plan and direct. Until a feeling of security and confidence spreads among the holders of capital we need not expect that any great activity in engineering circles will begin. If, therefore, we find that business is looking up, mills starting anew, repairs and renovation under way, we may fairly congratulate ourselves upon a "good time coming" soon.

There were several indications of a general revival of business last fall, but the Presidential contest in November, and the following uncertainty as to what would be the upshot of the matter, renewed the timidity which had prevailed before, and every one was inclined to wait for further developments. We now, however, gather from many sources, that everything is "on the mend," slowly to be sure, but all the more safely and strongly for that, and we feel confident that the country has fairly entered upon the beginning of better times.

It is possible that no one of the indications would alone be trustworthy, but the accumulation of evidence is too strong to be gainsaid. We propose to cite some of these facts so that every one can judge for himself. If we turn back to the railroad construction of 1876 we shall find that 2,442 miles of tracks were laid in that year against 1,561 in 1875, an increase of 57 per cent. As less track by nearly five hundred miles was laid in 1875 than in 1874, it is judged that an improvement has surely set in in this case. The manufactories in many places are starting again after a suspension of business, or are increasing their hours to full time, and, in some instances, to extra time. For example, taking the items at hap-hazard from our exchanges :—Wilson, Walker & Co. of Pittsburgh, are running full, having a very large order from the Pennsylvania and other roads to equip cars in their railroad specialties; the car-shops at Wilmington, Del., are receiving numerous orders for work, and are taking on a large number of mechanics; 3000 cars are to be called for by Southwestern railroads this spring; the Vulcan Iron Mills of St. Louis, are running full; the St. Louis Bolt and Iron Co. have large orders on their books; the St. Louis Car Wheel Works are running at their full capacity; the New Albany Rolling Mill has all it can do; The Dayton, O., Car Works have a number of orders; the business of Pittsburgh has felt a decided revival, and extra time is called for in nearly every mill. "The city of Fall River Mass., the largest cotton manufacturing centre in the country, has every one of its mills running on full time, The aggregate weekly production is 134,000 pieces of print cloths, and about 12,000 pieces of wide goods, and the weekly pay exceeds $100,000. There is no accumulation of goods, nor is there likely to be any over-production for a long time, as more than one-half of all the production of the print cloth mills is sold up to April at prices which insure a handsome profit. The balance sheet of nearly every mill in the city shows a satisfactory profit for the past six months, and some of the more fortunate show a very flattering result, while the wages of the operatives are ten per cent. higher than they were at this time last year."

In the Lehigh Valley iron works are again starting up. The low price of coal has a very favorable influence on the iron industry. The Bethlehem Iron and Steel Company has been doing an excellent business since New Year's, and its future prospects are exceedingly bright; the Crane Company are turning out a large amount of work; the Phœnix Iron Co., at Phœnixville, Pa., have secured the contract for a number of wrought iron bridges for Canadian parties, and will require the full complement of hands; the other establishments in the Schuylkill Valley are reported to be very prosperous. Works at Beaver Falls, Pa., at McKeesport, at Cleveland, O., have a good supply of orders and are running full. The Ellis Locomotive Works, of Schenectady N. Y., closed since October, have been opened with work for 400 men; the Winchester Arms Co., at New Haven, are very busy on Turkish contracts; in short, hardware, iron, and agricultural implement makers generally are doing an excellent business.

As activity in any direction helps general business also, it is well to note the great recent increase in our foreign trade. Evidence is already coming in that the Exhibition at Philadelphia has been of material benefit to us in introducing our manufactures and implements to the notice of foreigners. Inquiries are being made for our goods, sample and larger lots are being ordered, and some of our articles are displacing those of Great Britain in markets which have previously been hers without dispute, and even are competing in parts of England itself. The amount of exports is steadily increasing. The N. Y. *Bulletin* says:

"Not only are the old channels toward South America and the West Indies taking goodly supplies, but England, Germany, Russia, Italy, Australia and New Zealand are showing a gradual appreciation of the superiority of American hardware. Axes, edge-tools, axe, pick, hammer and hatchet handles, spokes, mallets, smoothing irons iron planes, meat and vegetable choppers, sausage stuffers, house-furnishing goods, fluting machines, builders' and plumbers' hardware and clothes wringers are all included in the exports, and each new order shows an increase."

Great quantities of American cottons have been sent abroad, and the shipments are increasing. Our large manufacturers are receiving letters soliciting consignments from places in which American goods have never been sold before. Representatives of several manufacturing houses say they are receiving large orders from foreign countries, principally South America, Australia, and the East Indies. Some of them have sent agents to open up trade and say that reports are very satisfactory. The goods now in demand in foreign countries are cotton and woolen fabrics, agricultural implements, weighing scales and sewing machines.

That our exports are more than our imports, as has not long been the case, is a very satisfactory state of things for us. In 1876 the excess of exports of merchandise over imports was $164,000,000. In the previous year it was only $8,000,000. The flow of specie therefore turns this way, and we find gold coming down. As the *North American* puts it—"There has been a deeper meaning than lay on the surface in the frequent items that have appeared in the English papers noting the successful appearance in British markets of one competing American product after another. Massachusetts cottons have been selling in Manchester, Connecticut edge-tools in Sheffield, and New York jewelry in Birmingham. The exports of the United States have been increasing, those of England decreasing." The Birmingham advices of the London *Times*, Dec. 25, say, "Further advices this week from Australia and New Zealand testify to the increasing growth of American competition there, and a material part of the orders sent to this country are for American made hardware, including not only edge-tools, but carriage fittings and iron work, locks, bolts, tin-plate ware, etc."

Business in America cannot fail to brighten under such impulses, and there will necessarily follow the plans for extensions, changes and internal improvements of all kinds, in which engineers are interested. We have no doubt that a feeling of confidence in a better season has become general, and such a cheerful temper is a sure precursor of better times. Let any of our readers reflect carefully on the facts we have laid before them and see whether they had not better bring out their instruments from retirement, dust off their note-books, sharpen up their pencils, and prepare for whatever may turn up. The NEWS will keep up with the times, and will promptly chronicle the inception of new undertakings.

NEW YORK CITY WATER SUPPLY.

Chief Engineer Campbell, of New York City in a report for the fourth quarter of 1876, relating to the Croton Water Supply states that the present aqueduct has a capacity of daily supply of about 95,000,000, which together with that stored in the city reservoirs is amply sufficient for the demands of the present population, and with proper guard against waste, will serve for some years to come. Assistant Engineer Benj. S. Church reports the conduit in excellent condition, in consequence of the repairs which were made during the season of drought last year, and the Chief Engineer considers that as the conduit has stood for 35 years uninjured that there is no immediate cause for apprehension. He however considers that the limit to the capacity of the present aqueduct to meet the consumption of the city is nearly, if not quite reached, unless the demand can be diminished by putting a stop to waste, which can be effected by the enforcement of the present laws, and thus postpone for some years the necessity for a new conduit, which in the present financial condition of the city is certainly advisable.

In reference to the 'water famine' which has been discussed quite freely in the past year, Mr. Campbell remarks as follows:—

The Croton River and watershed will furnish a supply of water for a city of more than double the present population of New York, and considered in connection with the additional supply which may be procured from other sources and led to the Croton basin presents the cheapest and most feasible system for the permanent supply of water to this city.

The Croton River itself being insufficient at times of minimum or diminished flow to meet the demand, it becomes necessary to resort to storage reservoirs, which can be drawn upon during the dry season. At the close of the present season (1877) there will be available two large artificial reservoirs, whose combined capacity will be nearly seven thousand millions of gallons. Adding the quantity which may be drawn from natural lakes nearly nine thousand million gallons may be relied on, in addition to the natural flow of the river, to keep up permanent and steady flow through the aqueduct. This amount may even be exceeded, as during the season occasional rains would in part refill the diminished reservoirs. Had the great reservoir now in process of construction been available during the past season the scarcity arising from the extraordinary drought of 1876—a drought unexampled for a period of fifty years—would not have been felt.

I am therefore justified in saying that when this reservoir is brought into use no scarcity can arise until the demands of the city shall exceed the capacity of the aqueduct. To make assurance doubly sure, however, and to guard against a possible breach in one of the reservoirs, it will be well to commence, within the next two or three years, a third reservoir, and to this end plans and estimates are being prepared by the Chief Engineer, so that the best site may be selected after careful comparisons and the work prepared for contract at the proper time.

The unprecedented drought of the past year and its effect upon the water supply of this city called forth many suggestions and propositions for meeting the deficiency by drawing from distant streams. I have already explained that the Croton River and basin are adequate for the supply of a city of more than 2,000,000 of inhabitants; but in investigating this important subject I have been led to look beyond the Croton basin and to consider what additional supplies may most feasibly and economically be secured for the unfailing and abundant supply of water to this great metropolis. My knowledge of the topography of the country immediately north of the Croton valley, obtained from reconnoisance, and surveys made several years ago, induced the belief that the water of the Housatonic River might be tapped and led by conduit to the headwaters of the Croton. A cursory survey recently made establishes the perfect feasibility of this plan at a comparatively modern cost. The Housatonic is a large river, having its source in the Berkshire Hills; and, in its southerly course through the State of Connecticut, approaches, at a point ten miles of the head of the Croton within two miles north of the New York State line. At this point, known as Bull's Falls, a tributary of the Housatonic breaks through the mountain range which divides New York from Connecticut, and opens a way for the introduction of a canal, by which the waters of the Housatonic may be led and discharged into the Croton basin. By means of this great auxiliary supply from a large river of the purest quality, the water supply of this great city may be considered assured, even for the distant future.

Of course legislative sanction of the State of Connecticut will be required in perfecting this plan. I will here enter into no further details of the project, as they will be embodied in a special report at some future time, but I have deemed it proper to make this brief allusion to the matter in view of its importance and of the general discussion which took place during the past season on the permanent supply of water for this city.

Plans are in course of preparation with a view to extending the high service system, by which all, or nearly all, the elevated portions of the city may be supplied by the method which has already given so much satisfaction. The power at present in use is applied up to its minimum capacity, and perhaps in the desire to afford all possible accommodation, this system has been a little too much extended. The additional works will be commenced during the present year, and will prove a valuable addition to the general water system of the city. As there are vacant lots belonging to the corporation reserved by the department for this purpose, and eligibly situated for their location, the expense will be limited to the cost of the works themselves.

The daily consumption of water by the city of Boston is twenty million gallons.

THE Secretary of the Civil Engineers' Club of the Northwest requests us to say that arrangements are not yet fully made for the excursion to New Orleans in April, but that at the next club meeting he hopes to be able to give all the necessary information concerning the trip.

THE present number completes the publication of the text of Baldwin Latham's celebrated Treatise on Sewerage and House Drainage; the remaining plates, together with the index and title page will be issued as soon as they can be got ready, when each of the present subscribers to ENGINEERING NEWS will be in possession of a volume independent of the journal itself, which, four months ago, could not be bought in America, and of which the last copies were sold at fifteen dollars each. In thus reproducing in a cheap form this valuable work we believe we will eventually draw a greatly increased attention to the subject of Sanitary Engineering, and afford the means of obtaining easily the latest information on the subject, besides directly promoting the business interests of the Engineering and Architectural professions, and with these also the interests of contractors, and of the various manufacturers whose products enter into the construction of sewers. We feel, therefore, that we are entitled to the hearty support of all these classes.

We expected to arouse considerable discussion among American Engineers on the subject of sewerage and drainage, but have not succeeded, and our original project cannot be carried out at present in its entirety. We will supplement the present treatise with a copy of specifications of sewers, and with some other matter of practical use to the professions interested, by which time the season will be far advanced and works of construction begun, when we expect to give all our available space to the matter of news gathering, and, as far as possible, assisting our readers to a weekly review of the Engineering business of the country.

IN our *Volume Two* is the valuable report of the Sewerage System of Chicago by the City Engineer, E. S. Chesbrough, together with specifications for the construction of sewers; we have a few of the numbers of *Volume Two* containing Mr. Chesbrough's Report on the Sewerage of New Haven, which can be had for twenty-five cents; the Report of the Sewerage of Boston we published in full in Volume Three, but it is out of print; another most valuable report is that of the city of Providence, R. I., by J. Herbert Shedd, Chief Engineer of the Providence water works; there is also a great deal on the subject being published by various State Boards of Health, and, we believe, some treatises on American practice are being prepared for publication. The indications are that with an improvement in the financial condition of our cities and towns, the people will be awakened to the necessity and the benefits of improved sanitary conditions in their streets and dwellings.

LAST YEAR we decided not to keep "back numbers" of ENGINEERING NEWS, and that policy will be continued even more rigidly this year, and after the close of each sucessive quarter it may be taken for granted that the chances for replacing a lost or mutilated number will be very poor indeed. Subscribers will therefore see the necessity of preserving every number, and of notifying us promptly of the loss or injury of any particular one. If anything is lacking in our method of protecting papers from injury in the mails, or in addressing them to subscribers, we want to be informed of it; but having done the best we can, we cannot be expected to stand all the expense of replacing lost or injured copies; where *we* are not to blame therefore, we expect the retail price of the papers required to be sent in all cases; it is a small sum for each individual, but may be considerable in the aggregate to us. The sheets of "Sanitary Engineering" will not be for sale after this month except in book form when the price will be very nearly, if not quite, as much as the yearly subscription to the paper which at present includes the other.

CORRECTION.

In the paper on "Cements and Concrete," current in the NEWS, on page 62, first column, seventh paragraph, second line "the quantity required" should read, "the quantity *of water* required," etc.

IMPORTANT DECISION BY THE U. S. SUPREME COURT.

The long contested suit for the ownership of the dredging machinery, formerly belonging to the bankrupt estate of Fox and Howard, was decided by the Supreme court last Monday, the 19th inst., and forever set at rest, and the ownership established in C. S. Crane, who is now president of the Chicago Dredging & Dock Co., which said corporation have been in possession of this machinery since May, 1876. The machinery in question comprises four dredges, five pile-drivers, two steam derricks, three tugs and about twenty scows.

A brief history of the case is as follows: C. S. Crane purchased the said property of the provisional assignee of the said bankrupts for $40,000, the sale being confirmed by the district court, and a day being set for the payment and delivery of the property. The assignee was prevailed upon by Conro and Carkin to receive a higher bid in the interim, for $40,500, and to have the sale to Crane set aside and confirmed to them, which was done by the district court, and the property was turned over by the assignee to them.

Crane obtained an order from the circuit court to have the case opened in the district court, and testimony taken, which was done, and the district court decided against Crane and in favor of Conro and Carkin. On a petition to the circuit court for a review, the circuit judge reversed the decision of the district judge and established Mr. Crane in his rights to the property from July 9th, 1875, with the earnings from that date, giving at the same time his opinion that no appeal could lie from his decision to the Supreme court.

Notwithstanding this, Conro and Carkin procured from Judge Davis, of the Supreme bench, an appeal upon the question of jurisdiction, which said appeal was summarily dismissed by the Supreme court on Monday last.

THE BROTHERHOOD OF LOCOMOTIVE ENGINEERS.

(*From the Nation.*)

That the recent strike of locomotive engineers of the Boston and Maine Railroad has ended in the complete and utter discomfiture of the most powerful trades-union in America is matter of public congratulation. It was the fifth movement of the kind, all emanating from the same source and carried on by the same system of tactics, which had taken place within six months. With possibly one exception all of the four preceding strikes had been successful, and the two most recent and noticeable of them, that on the New Jersey Central last autumn, and that on the Grand Trunk in December, had been brilliantly successful. They were, too, all of them part of a system, and a system which actually threatened to take the control of the train movement of the railroads out of the hands of the corporations owning them, to put it in the hands of the officers of the Brotherhood of Locomotive Engineers.

The "striking" policy, if such it may be called, of this association dates from about three years back. Up to that time its objects had been of a social and benevolent character, and in these respects it appears to have done some very good work. It was an organization into which any respectable locomotive engineer could get admitted; it inculcated principles of sobriety and self-respect, and through it a certain provision was made in cases of destitution arising from the sickness or death of its members. In 1873 it included in its numerous divisions about six thousand engineers; it was looked upon with favor by the railroad corporations, and it seemed to be the effort of those controlling it to encourage a feeling of common interest and good-will between employer and employed. The whole machinery of the organization was, however, one which admitted of a very easy perversion to other ends. It needed only to fall into the hands of demagogues; and this was almost sure ultimately to happen. It did happen early in 1874.

Up to the time of the panic of 1873 the locomotive engineers of this country, like almost every one else connected with railroads, had little cause to complain. It was with them harvest time all the year round. Competent engineers could not be found to supply the demands of new roads and the rapidly-increasing number of trains on old ones; situations were plenty; wages were high and rising. Indeed, the pay of first-class engineers kept going up until it amounted to over $1,200 a year. Then came the general railroad collapse, and with it measures of economy and reductions of pay. These, as was natural enough, when it came to their turn, the engineers resisted, and in resisting them they no less naturally bethought themselves of the Brotherhood. If they could but unite in a trades-union which should practically include all the competent locomotive engineers of the country, they might well hope to be absolute masters of the situation and to dictate their own terms. Few people who have had no practical experience in operating a railroad can realize on what good grounds this hope rested. Nine persons out of ten who talk of railroad strikes, have a vague sort of general idea that almost any one who understands a locomotive could run one on any given railroad. As well might any one who has a smattering of seamanship undertake to pilot a vessel into any and every harbor. A railroad is a very complicated concern. It is almost made up of curves, grades, crossings, switchings, and sidings; it is operated on a most complicated schedule, and it is buoyed and beaconed from end to end with targets, signals, and whistling-posts, not one of which can be safely disregarded. A competent engineer must be familiar with every in and out of his track; and while running at forty miles an hour with his hand on the throttle-lever, must know exactly where to look for each signal and how to read it at a glance. To one not accustomed to the work, the rapid approach to a great city on a locomotive in the night is almost appalling. You seem to plunge forward into a darkness made visible by the glare of the head-light; while, amid the myriad lamps of streets and houses, you try in vain to distinguish the lanterns which tell the engineer that switch and drawbridge are right, that the crossing is clear, that the station is open. All these he picks out as if by intuition, and all these a novice, no matter how much he may know of a locomotive, must learn before he can take his place. When, therefore, the engineers of a great railroad—a railroad the running of which can on no account be stopped for even a day—strike work in a body, it is with the corporation which operates it much as it is with a man who drops from paralysis. All this the locomotive engineers of the country know well enough, if those who travel behind them do not; and they knew it just as well in 1873 as they do now.

It was not long after the panic of that eventful year that the inevitable collision came. It was brought about in consequence of a reduction of wages on the leased lines of the Pennsylvania Railroad west of Pittsburgh—those worked by the Pennsylvania Company. The engineers refused to accept it, struck, and appealed to the Brotherhood for its support. A man named Wilson was then at the head of the organization, who had the good sense to see that it could not live in hostility to the railroad companies, and would soon make itself a public nuisance by a reckless use of its dangerous power. The Brotherhood accordingly refused to countenance the strike, and after a time it broke down. Chief-Engineer Wilson, however, was unable to sustain himself; the war party was in the ascendant, and, at the next election of officers, he was thrown out and P. M. Arthur was installed in his place, representing the new aggressive "striking" policy The Brotherhood now numbers some 13,000 members, and possesses an accumulated fund of about $500,000 It is controlled by three salaried officers who have their headquarters at Cleveland, Ohio, and whose power, for the time being, is practically absolute. They cannot, it is true, nominally order strikes; but nevertheless Mr. Arthur's recent assertion in Faneuil Hall, that he had only to raise his hand to stop every railroad running out of Boston, was no vain boast. During a day or two he undoubtedly could have done it. Outwardly the Brotherhood never organizes strikes; it even professes to disapprove of them. All it does is to consent to them; but its consent carries with it the support of the whole order, with all its funds and influence over individuals, while without its consent a strike is practically impossible. If made, the order will crush it out at once by supplying men to fill the strikers' vacant places. The system is, therefore, ingeniously contrived to give power and to evade responsibility for its use. Nominally, the Brotherhood is still a social and charitable institution, exerting its influence in favor of a better understanding between the railroad corporations and their employees; practically, as now managed, it is a powerful machinery for demoralizing railroad employees, organizing strikes, and rendering them effective at the cost of the public.

The Boston and Maine strike was peculiar in only one respect: for the first time the rights of the community were in that case asserted and brought emphatically to the front. The State Board of Railroad Commissioners intervened, and took the ground that, as respects its railroads, the public has rights paramount to those of either corporation or employees, and those rights have got to be respected. It is certainly very curious that this position had never been taken by any public officers before. The presence of this new and formidable opponent, assuming the burden of the contest in the name of the public, evidently took both parties to it completely by surprise. These strikes had, indeed, become of late so common that the people of the country, with characteristic good nature, seemed actually to have begun to conclude that they had no rights in the matter; that a band of discontented railroad employees had a sort of common-law right to abandon trains, block railroads, and paralyze the whole movement of trade and travel in order to settle some trifling dispute over wages, or hours of labor, or systems of promotion. That this should have been so is a singular illustration of the prescriptive privilege which labor by a sort of tacit popular consent here enjoys over capital. The engineers did, as a matter of course and without thought of being challenged in the doing, what no railroad corporation has ever dared even to hint at. It is almost amusing to think of the public indignation which would have been excited had the greatest "railroad king" the country ever saw—Scott or Vanderbilt—dared to stand up and say what Chief-Engineer Arthur said (without any idea, by the way, of the significance of what he was saying) the other day in Boston. What board of directors ever dared to suggest the idea of meeting the Granger movement by a strike? What railroad ever stopped running because it had a quarrel on its hands, and to stop was the shortest way out of it? Yet in six months the Brotherhood, to settle some trifling matters of dispute, had actually stopped four railroads; its head official was now threat-

ening "to make the grass grow" over a fifth, and publicly boasted of his power to bring to a standstill every railroad running in and out of one of our largest cities, if so doing was necessary to secure that result. And yet the public seemed to think there was some distinction to be made between such a threat coming from Mr P. M. Arthur, Chief-Engineer of a Brotherhood of thirteen thousand engineers, and Cornelius Jay Scott, we will say, the representative of ten times as many millions of dollars. Accordingly, Mr. Arthur was allowed to do on an average once a month what, if attempted, would have sent in less than twenty-four hours its railroad out of the hands of the strongest corporation in the country into those of a a receiver. It certainly, therefore, was high time that Mr. Arthur and his Brotherhood received a plain intimation from some quarter that the community had an interest in his proceedings. They have received this at last; but we have some reason to suppose that the struggle is not yet over. At any rate, the matter has assumed such magnitude, that the best way of guarding against these strikes is a question of much importance, and is now exciting great attention among railroad men.

CORRESPONDENCE.

ST. LOUIS, *March 20, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—In looking over your interesting number for March 3d, I find that the "Method of Keeping Notes of Railroad Curves" on page 56 is identical in principle with that described in volume for last year in article V of "Engineering Field Work" Aug. 26, 1876, to which I refer your contributor. C. A. S.

SHAWANO, WIS., *March 15, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—A lumber "famine" is now a fixed fact throughout these Northern regions. The outlook is very gloomy indeed; millions of feet of logs have been cut and skidded, but we have had very little or no snow to *bank* them, and it looks now as though we will not have any more this season, and if we do the sun is so high that it will soon melt away. The lumbermen are very despondent, and the poor choppers and sawyers more so. A general failure of the winter wheat crop here last year, followed by the present failure of the lumber "crop" will make hard times the coming season. J. M.

We think there must have been enough snow since our correspondent's letter to authorize the hope of brighter prospects, —ED.

SCITUATE, MASS., *March 15, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—A considerable sum of money has been spent here and in other towns along the coast of Massachusetts, in trying to determine the relative ownership of the beaches. The ke p and rockweed which lands on these beaches make an excellent land dressing and in the event of a decision in favor of a few who claim a legal title to these beaches, all the sea manure landing there becomes the r exclusive property. Now it seems to me that this is a question of boundaries, and that a surveyor is the person to judge, as all lands bordering on the beaches are claimed to hold the beach itself by the owners of these lands. I should like very much to hear the opinion of the profession on this subject. W. Y.

ROCHESTER, N. Y., *March 13, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—Your correspondent, John Ryall, refers to my communication and finds an error in the calculation in which I acknowledge him to be correct. But that does not affect the result of my conclusions in regard to the correctness of the formula as modified by Mr. Kirkwood.

I would like to obtain Mr. Ryall's views, or any other engineer's views as to the correctness of the modified formula $m = 3808 \sqrt{\frac{D^6 H}{L}}$ or $D = \left\{ \frac{m^2}{1450\, S} \right\}^{\frac{1}{6}}$

where m = the cubic feet per second, D = diameter, H = head, L = length and S = head divided by the length all in feet.

Mr. Ryall says "using the sixth root, however, the result in cubic feet is 25 and the average 50 nearly." I would like to know which formula he considers correct, the one which gives 17 or the one which gives 25 cubic feet per second. L. L. NICHOLS.

GRAPHICAL ANALYSIS OF ROOF TRUSSES BY PROF. CHAS. E. GREENE.

EDITOR ENGINEERING NEWS:

SIR.—I have just received a copy of the above named work, and I do not hesitate to pronounce it the best book on the subject that has yet appeared. It is so eminently simple as to be exactly fitted for working architects and builders, the majority of whom are neither able or willing to thresh the few grains of wheat out of the intolerable mass of chaff which so loads down many of the recent volumes on engineering matters. If a writer on technical subjects wishes to prevent the use of a book among workingmen he has only to hoist his flag with the sign of integration upon it and no one will ever trouble his work. Too many of our engineering writers at the present day seem to think that a book to be of service to the profession must be crowded with the higher mathematics, forgetting the maxim of a distinguished English engineer, that the value of mathematics to the practitioner is in inverse ratio to its difficulty. If all engineering was done by accomplished scholars there might be no harm in invoking the aid of the calculus in setting slope stakes, or in finding the center of gravity of a wheelbarrow in order to estimate the cost of earthwork; but since the bulk of real work is done by men who have forgotten their higher mechanics, if indeed they ever knew anything about it, it seems quite proper that some at least of the books should be suited to this class. Where *one* roof is put up by an architect who is familiar with the computation of strains, *a dozen* are erected by ordinary builders who simply follow the rules of their apprenticeship, not knowing whether they are right or wrong. I recollect a short time since asking a carpenter how he reckoned the strains in a wooden roof of a somewhat complex design, to which he replied:—"Strains! bless your soul, there ain't any! All I did was to make the roof strong enough to hold the load." I did not refer him to Rankine, nor bother him with *bending* or *shearing moments*, but sketched for him on the floor with a piece of chalk a diagram from Prof. Greene's book, and you should have seen that man's face light up. The roofs which *that* carpenter now builds *have* strains, and he knows where and how much they are. I have used Prof. Greene's papers on roofs, as given in the NEWS, with my students during the past year, and hereafter his book will be their manual on this subject. GEORGE L. VOSE.

Professor of Civil Engineering, Bowdoin College, Maine.

COMPARATIVE COST OF COAL AND OIL GAS.

HICKSVILLE, O., *March 21, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—The cost of gas light, although one among the most serious questions of business and domestic economy, is perhaps less understood than any other matter of equal importance among the economies or luxuries of life.

Without going into an examination of the per entages of possible light obtained in actual practice further than to say that ill-proportioned burners will readily, and frequently do, cause a loss of fifty or more per cent. of light, and that it is economy to use a *small number of large burners*, rather than a large number of small ones, whenever practicable, I desire to call attention only to the cost of gas itself, and the necessary incidental expenses attending its manufacture, as shown in the following estimates of the cost of gas made from coal and from oil. These estimates show the actual cost of gas making, exclusive of interest, for the various named small productions, ranging from 1,000 to 10,000 ft. per day, and are based on coal of best quality at $6.00 per ton or oil at ten cts. per gallon, with productions in each case representing the ordinary yields obtained from these materials with first-class apparatus.

COAL GAS. 14 Candles Standard.		OIL GAS. 14 Candles Standard.	
Example No. 1.		*Example No. 1.*	
Works costing about $2,000.		Works costing about $2,000.	
Making 1,000 feet per day;		Making 1,000 feet per day;	
Wages 1 man, daily	$1.50	Wages 1 man, ¼ time	$ .40
200 lbs. coal	60	3 gallons oil	.30
Lime, repairs, etc.	70	Fuel, repairs, etc.	.30
Cost of single 1,000	$2.80	Cost of single 1,000	$1.00
Example No. 2.		*Example No. 2.*	
Works costing about $3,500.		Works same as as above costing about $2,000.	
Making 2,500 feet per day;		Making 2,500 feet per day;	
Wages 1 man, daily	$1.50	Wages 1 man, ½ time	$ .80
500 lbs. coal	1.50	7 gallons oil	.70
Lime, repairs, etc.	1.00	Fuel, repairs, etc.	.55
	$4.00		$2.05
Cost per 1,000, $1.60.		Cost per 1,000, 82 cts.	
Example No. 3.		*Example No. 3.*	
Works costing about $5,000.		Works (same as before) $2,000.	
5,000 feet per day; wages one man (higher grade)	$2.00	5,000 feet per day; wages one man	$1.50
1,000 lbs. coal	3.00	14 gallons oil	1.40
Lime, repairs, etc.	1.50	Fuel, repairs, etc.	1.00
	$6.50		$3.90
Cost per 1,000, $1.30.		Cost per 1,000, 78 cts.	
Example No. 4.		*Example No. 4.*	
Works costing about $8,000.		Works costing about $4,000.	
10,000 feet per day; wages one man	$2.00	5,000 feet per day; wages one man	$1.50
2,000 lbs. coal	6.00	28 gallons oil	2.80
Repairs, Lime, etc.	2.00	Fuel, repairs, etc.	1.70
	$10.00		$6.00
Cost per 1,000, $1.00,		Cost per 1,000, 60 cts.	

In the foregoing examples it will be observed that the oil gas works have, for the very small consumption, a decided advantage over those for coal gas in the fact that they can be readily managed so as to make a supply of gas sufficient to last for two or more days, and then can be allowed to remain with fire out, and without any care whatever, until the supply is exhausted, whereas the manufacture of coal gas should be carried on daily, with fires kept over night. One result of this is to compel, in small coal gas works, the use of *all* coke made, as fuel, and another result is that the constant attention and large proportion of fuel required make the manufacture of coal gas, on a small scale, comparatively expensive, while the oil gas-making can be carried on in a small way to almost as good advantage as on a larger one.

The grade of labor required, and amount of experience needed to manage a small coal gas works, renders it liable to higher rates of wages than for oil gas making—a liability that amounts to a certainty, bearing in mind the extra work involved in making—5,000 to 10,000 feet per day, with one man.

It will be observed, too, that as the production increases the relative difference in cost decreases, until the 10,000 feet per day is reached; but beyond that amount additional labor would have to be employed in the coal gas making and not in the oil gas, until a much larger amount is reached, so that the difference in cost per 1,000 would be greater for amounts above 10,000 feet per day, than for that amount.

While the figures here given are those of actual results in every day working, under widely diverse localities and circumstances, they are not intended to represent the cost of gas as made *and sold* by gas companies, who in the smaller cases frequently have unavoidable expenses of interest, collection, and waste, aggregating more than the mere cost of gas making materials and labor; and in some of the larger cases, whose enormous business enables them to make extraordinary terms of freights, and purchase, on coal and oil, and to economize labor of manufacture and collection to a degree unattainable by the smaller works, and to sell large amounts of residual products, especially coke, the costs of manufacture *and sale* are materially less than those here given for manufacture alone.

J. DESHA PATTON.

BOOK NOTICE.

A TEXT-BOOK OF MINERALOGY. With an extended treatise on Crystallography and Physical Mineralogy. By Edward Salisbury Dana. On the plan and with the co-operation of Professor James D. Dana. New York: John Wiley & Sons. 1877.

Professor J. D. Dana's works on Mineralogy have been for so long a time recognized as the standard in this country that any new volume, in the preparation of which he has taken an active part, is sure to meet with a hearty welcome. The need of a revision of his Manual of Mineralogy, which has not appeared in a new edition for twenty years, or of some new work, to occupy an intermediate position between the Manual and his system of Mineralogy, has long been felt by all students and teachers of the science. After the publication of the fifth edition of the System of Mineralogy 1868, Professor Dana undertook the preparation of a text-book, which should supply that need. But the state of his health was such as to prevent his carrying out the proposed plan, and the editorship of the volume was at last placed in the hands of his son, Mr. Edward S. Dana, in whose name it has just been published. The new volume is, strictly speaking, neither an enlargement, an abridgement, nor a new edition of either of Professor Dana's above mentioned works, yet in some respects it may be regarded as combining the advantages of all three, as will be seen from the following review of its contents:

Part I. (168 pp.) is devoted to Physical Mineralogy. It comprises Crystallography, both descriptive and mathematical, treated according to the system and method of Naumann, and a description of the physical characters of minerals. A generous amount of space is given to an explanation of the principles involved and the apparatus employed in the study of the optical characters of crystallized substances. This branch of the subject has acquired increased importance since the application of the microscope in determining the mineral constituents of rocks has become common.

In Part II. (24 pp.) the subject of ch mical Mineralogy is taken up. The treatment is brief, but from it any person tolerably familiar with the nomenclature and methods of inorganic chemistry can get a clear idea of the significance of the formulæ used to represent the chemical composition of mineral species. Throughout the book the new chemistry is followed in the writing of formulæ. We notice the omission of a subscript 3 after Si in the formula near the bottom of page 176.

Part III. (205 pp.) is Descriptive Mineralogy. The classification is the same as that in the last edition of Dana's System of Mineralogy. Only the most important species, however, are described in full, and the descriptions are made short by the omission of the synonymy and of nearly all the analyses. Descriptions of new species are inserted in their proper places Following Part III. there are four appendixes, comprising a synopsis of Miller's system of crystallography, rules for the drawing of figures of crystals, tables to assist in the determination of minerals, and a catalogue of American localities of minerals.

The book is handsomely printed and doubtless will meet with a ready sale.

SPECIFICATIONS *

OF LABOR AND MATERIALS FOR THE IRON ROOF-FRAME OF THE STEAM ENGINEERING STOREHOUSE, NO. 4, AT THE U. S. NAVY YARD, LEAGUE ISLAND, PA. GEN. F. A. STRATTON, ENGINEER IN CHARGE.

The Roof Frame will be built in five parts, to wit: a mansard roof frame for the central building about sixty-nine feet, three inches (69′ 3″) square, and for each of the two end pavilions, each about sixty-four feet, three inches (64 3″) square, and a double pitch roof-frame for each of the two intermediate curtains, each about fifty-nine feet, six inches (59′ 6″) wide, and one hundred feet (100′) long, as shown by the drawings.

The Materials for the roof-frame will include all the wrought iron and cast iron work shown by the drawings, or enumerated in the schedule hereto appended, or in these specifications, and all wall-plates, hold-down bolts, ties, strutts, braces, rods, plates, bolts, screws, rivets, nuts

* Owing to the amount of drawing now on hand for other matters, we are unable to re-produce that accompanying these specifications.

and washers, and all other fastenings, bearings, connections, parts and appurtenances of the roof-frame, whether shown by the drawings enumerated in the schedule, or described in these specifications, or not, so as to properly and fully execute and complete the work in a strictly first-class, and the best workmanlike manner, as required by the true intent and meaning of the drawings and specifications, or by the form, dimensions and arrangement of the buildings, as determined and directed by the civil engineer in charge of the work.

The Labor for the roof-frame will include all the mechanical and other workmanship or labor, on the materials above described, necessary and proper for constructing and erecting, adjusting, fitting and fastening the same, in place, (except setting the wall plates) in a thorough and workmanlike manner according to the drawings and these specifications, all labor for erecting and taking down scaffolds, and all other workmanship and labor, whether shown by the drawings, or described in these specifications or not, so as to properly and fully execute and complete the work in a strictly first-class and the best workmanlike manner, as required by the true intent and meaning of the drawings and specifications, or by the form, dimensions and arrangement of the building, as determined and directed by the civil engineer in charge of the work.

The Contractor will Furnish all the labor and all the materials for the roof-frame, as herein described, including the use of all the machinery, tools and appliances needed in connection therewith, and fully complete the same, ready for the wooden purlins, sheathing and other woodwork of the roof, and to the acceptance of the civil engineer in charge of the work.

The United States Government will Furnish lumber and rails for the scaffolding needed as determined by the civil engineer. The Government will also furnish the use of cars for transportation in the yard, but no locomotives, horses or carts, nor any other means or facilities for transportation of men or materials, by land or water, nor will it furnish any blocks, falls, derricks, sheers, tools or appliances whatever; but all such articles and appliances, except as herein specified, will be furnished by the contractor at his own cost, risk and expense.

Wrought Iron.—The I beams for rafters and braces, channel-bars for wall plates of mansard roofs, angle-irons, desk plates, bar irons, struts, braces, knees, ties, splice plates, bolts, screws, nuts, washers, rivets and other fastenings, and such other parts as directed, will be of wrought iron of American manufacture of the best quality for their several purposes, and free from all defects.

Cast Iron.—The wall plates for curtain roofs, hubs for center of mansard roofs, bearing boxes, purlin brackets, and such other parts as directed will be of cast iron of the best quality for their several purposes, sharp, smooth, clean, sound, and free from all defects.

Paint.—The paint will consist of pure linseed oil, the best quality of oxide of iron pigment, and a good dryer, all in proper proportions.

Form, Dimensions and Weights.—All cast iron and wrought iron materials, or parts of the frame, as herein described, will be true to the form, dimensions and weights required by the drawings, schedules or specifications, or where not so described, as directed.

Joints, Fittings and Bearings.—All joints, fittings and bearings will be close, true, and well made; and where required by the drawings or specifications, or as directed, will be planed, turned, or otherwise carefully fitted.

Fastenings and Connections.—All eyes, eye-bolts, fish plates, splice plates, knees, angle plates, anchors, screw eyes, bolts, nuts, screws, rivets and other fastenings, and connections, will be of the best form and proportions, so as to make secure, strong and perfect fastenings or connections for their respective purposes, equal to the best standard for such work, and made, fitted and fastened in the best and most workmanlike manner, as directed.

Rafters.—Each rafter will be in one piece, excepting rafters A and H, which may each be in two pieces jointed at the column supports, the joints to be dressed to a full bearing surface, and each securely fastened with two fish plates and six rivets.

Wall Plates and Deck Plates.—The wall plates F and N, and the deck plates G and O, may each be made in not more than three pieces, with butted joints, as directed.

Peak Angles, etc.—All peak angles, and other similar joints, will be secured with splice plates as wide as the flanges will permit, and as directed.

Rafters B, D, I and L.—The heels of rafters B and D, and of I and L, will be well fitted to the *Wall Plates N and F* respectively, as shown, and fastened with splice plates, as directed. Each of the wall plates F and N, will be fastened to the wall with one inch (1") bolts, two feet three inches (2' 3") long, in clear, each bolt having a large washer walled in at its head.

Rafters P and Shoes.—The heels of rafters P will be well fitted to cast iron shoes which will be bolted to Cast iron Wall Plates, Q, each of which will be secured to the wall with two one-inch (1") bolts, two feet three inches (2' 3") long in the clear, all as shown by the drawings, and as directed.

Knees.—The joints of rafters A with rafters B, and of rafters H with I, will be secured by rough iron knees of four inch by three and three-quarters inches (4"× 3¾") T iron, with legs fifteen inches (15") long, riveted to the flanges with six (6) rivets through each leg.

The joints of rafters C with rafters D, and of rafters K with L, will be secured by wrought iron knees of three and one-half inches by three and one-half inches (3½"× 3½") T iron, with legs nine inches (9") long, riveted to the flanges with four (4) rivets through each leg.

Deck Plates.—The deck plates G and O will be secured to the end of each rafter of the upper roofs by two pieces of angle iron, four by four inches (4"× 4") of sufficient length to fill the space between the flanges of the rafter and secured by three (3) rivets in each leg of the angle iron. The joints of these deck plates G and O will be made opposite the ends of the rafters and secured by an angle iron on each side of the beam and a fish plate in front eight inches (8") wide and one-fourth inch (¼") thick.

Hip Rafters A and H and rafters C and K.—The hip rafters A and four of the rafters C in the end mansard roofs, and the hip rafters H and four of the rafters K in the center mansard roof, will be secured at the apexes of the roofs to cast iron hubs, as shown by the drawings and as directed. Each rafter will have a wrought iron knee on each side of the web, one leg of the knee being riveted to the web with four (4) rivets three-fourth (¾") of an inch in diameter, the other leg being bolted to the central hub with two (2) bolts each three-fourths (¾") of an inch in diameter, all as directed. The rafters A and H will be supported on cast iron bearing boxes with turned bearings and sockets resting on *Wrought Iron Columns* of the Phœnix pattern B, three-eighths (⅜") of an inch thick. Each of these columns will be turned at the ends and closely fitted to the cast iron bearing box at its top, and to the cast iron joint box at its base. These castings at the base and top of each column will be fitted closely to the inside of the column, and bolted to it by a through bolt one inch (1") in diameter.

Braces E and M.—The braces E and M will be trussed with round rods one and three-eighths inch (1⅜") in diameter, and a strutt of the Phœnix A column pattern one-fourth (¼") of an inch thick, placed at the middle of the brace or beam.

Ties.—Two additional ties of one and three-eighths inch (1⅜") round iron will extend from the foot of each strut to near the middle of the columns, as shown and as directed. Ties of one and three-eighths inch (1⅜") will be fastened to the hip rafters A and H near the columns by means of a through screw bolt one and a half inches (1½") in diameter, and will extend thence to the center where they will be secured to a wrought iron strut which will be fitted with set nuts and fastened to the central hub, all as show by the drawings, and as directed.

Purlin Brackets.—Purlin brackets of cast iron, as shown, will be made, fitted and fastened to the rafters, as directed.

Wall Plates, etc.—The contractor for the roof-frame will furnish the castings, channel-bars and hold-down bolts for the wall plates, and give all necessary information and assistance for the proper setting of the same, the contractor for the walls of the building having contracted to set and fasten the same properly in place ready to receive the roof frame.

Painting.—All iron work will be painted with one good coat of oxide of iron paint, carefully laid on.

Scaffolding.—The contractor will erect all scaffolds, remove the same, and pile up the materials thereof near the building, as directed.

Quality of Workmanship and Materials.—All workmanship will be executed in a careful, thorough and workmanlike manner, and all materials will be of the best quality of their kind for their several purposes.

Inspection. All workmanship and materials will be subject to the inspection and approval or rejection of the civil engineer in charge of the work, who will have full power, at any time during the progress of the work, to reject any workmanship or material which, in his opinion, is not of the quality or kind required by the contract, or by the drawings and these specifications, or by the character of the work to be executed.

Rejections.—All work so rejected, will, upon notification to that effect, by the civil engineer, be forthwith taken down and rebuilt or otherwise made good to the acceptance of the civil engineer; and in case of any failure of the the contractor to forthwith take down and rebuild, or otherwise make good, as above specified, any rejected workmanship, upon being notified so to do, by the civil enginineer, then the said civil engineer may employ workmen to perform such work at the cost and expense of the contractor, and the amount of such cost and expense shall be deducted from the price to be paid under the contract.

All *materials* so rejected will be immediately removed from the premises and replaced by other materials conforming to the requirements of the drawings and these specifications.

All measurements and verifications of the work shall be made and determined by the civil engineer.

In case of dispute the decisions of the civil engineer in charge of the work will be subject to the revision and the approval, alteration or rejection of the commandant of the navy yard, or the chief of the Bureau of Yards and Docks.

Time for Delivery of Wall Plates, etc.—The wall-plates and their hold-down bolts will be delivered to the contractor having the contract to build the walls of the building, on or before the fifteenth (15th) day of April, eighteen hundred and seventy-seven (1877), or as soon thereafter as directed.

Time for Commencing and Completing the Work.—The erection of the roof-frame will be commenced not before the twenty-fifth (25th) day of April, and not later than three (3) days after the walls of the center building and its wall plates shall be ready for the rafters, as determined and decided by the civil engineer in charge of the work; and said roof-frame will be completed in place, as herein specified, not later than thirty (30) days from the date for commencement, as above specified, or at any time after said thirty (30) days, not later than ten (10) days after the entire walls and their wall plates shall be ready for the reception of the rafters, as determined by the civil engineer.

The roof-frame of the central building will be commenced and completed first in order.

As directed.—The phrase "as directed," where used herein, will be construed to mean "as directed by the civil engineer in charge of the work."

The price named in the contract will be for the roof-frame and its appurtenances complete, including all labor and materials necessary for its full and entire construction, erection and completion in place, as herein specified.

Schedule of Beams, etc.—The schedule of the principle beams, etc., for the roof-frame is as follows:—

No. of Pieces.	Section.	Weight per yd.	Marks.	Remarks.
8	12" I beam.	170 lbs.	A	Hip rafters end roof.
8	10½" I "	105 "	B	" sides " "
88	8" " "	65 "	C	Com'n rafters end roof.
88	8" " "	65 "	D	" " sides end roof
8	10" " "	105 "	E	Truss'd " supports "
8	10½" chan'l	60 "	F	Wall plates "
8	8"×¾" pl'te		G	Deck plates "
4	12½ I beam.	170 "	H	Hip rafters, centre roof.
4	10½ I "	105 "	I	" sides, " "
52	8" " "	65 "	K	Com'n r'ft'rs " "
52	8" " "	65 "	L	" " sides " "
4	10½" "	105 "	M	Truss'd " supports "
4	10½" chan'l	60 "	N	Wall plates centre roof.
4	8"×¾" pl'te		O	Deck plates " "
56	6" d'ck beam	45 "	P	Common rafters for double-pitch roof, for curtains (28 trusses).
56			Q	Cast-iron wall plates.

Cast iron wall plates Q will weigh forty-five (45) lbs. each. Cast iron shoes resting on wall plates Q will weigh forty-five (45) lbs. each. There will be twelve hundred and forty-five (1,245) purlin brackets weighing about eleven (11) pounds each, and five hundred and sixty (560) purlin brackets weighing about ten and a half (10½) lbs. each. Splice plates at heels of rafters B, D, I and L, will be made of six (6) inch by one-half (½) inch bar iron with legs having an average length of four (4) inches each. Splice plates at the peak angles of the double pitch roofs will be made of four (4) inch by five-eighth (⅝) inch bar iron, with legs each ten (10) inches long, arranged to receive the pins of the truss rods.

Fish plates for joints of the deck plates will be eight (8) by ten (10) by one-quarter (¼) inches.

Angle knees at center hubs will be made of six [6] inch by one-half [½] inch bar iron with one [1] leg two and three-quarter [2¾] inches long and the other five and a half [5½] inches long.

Angle knees at joints of rafters C and A, and of rafters C and H will be of six [6] inch by one-half [½] inch bar iron with legs each five and a half [5½] inches long.

In addition to the knees specified in the foregoing specifications for the joints of rafters A with rafters B, and of rafters H with I, and rafters C with rafters D, and of rafters K with L, there will be for each of said joints two [2] wrought iron knee plates, one on either side, to be five [5] inches wide, one-half [½] inch thick, the lower leg five [5] inches averaeg length, and the upper leg as long as the width of the flange will permit.

THE engineers for the Severn Bridge Railway report that the Hamilton's Windsor Iron Company have continued to make satisfactory progress with the contract notwithstanding the unfavorable weather prevalent during the winter. The cylinders for twelve piers are now founded in the rock and filled with concrete. The foundations of three others piers are in progress. Ten of these piers have been carried up to the full height and completed to under side of girders. Nine spans of the superstructure are erected and completed, so that about 400 yards, or one-third of the entire length, is practically finished, The swing bridge across the new canal is nearly completed. The iron work for the swing bridge over the old canal is now being delivered. The large circular masonry pier to carry this bridge (built partly in the canal and partly in the river) is well advanced and out of all difficulty of construction. The foundation for the adjoining masonry pier in the river is also nearly completed. The cast iron for cylinders machinery, etc., delivered, including those fixed, is about 2,800 tons. The wrought iron delivered is 2,400 tons. The works of the other contractors in the railway approaches are not making such progress as could be wished. The total earthwork completed is about 116,000 cubic yards. Two of the piers of the masonry viaduct at Purton (part of the Severn bridge) have been commenced. The timber viaduct across the docks at Sharpness is nearly completed. The heading for the tunnel has been driven throughout.—*Architect*, (*London.*)

Work on the Sudbury River Conduit, Boston New water works, will probably be resumed early in April.

WANTED—A TEXT-BOOK ON CIVIL ENGINEERING.

We have heard it suggested many times that there is a great need of a work on Civil Engineering which shall answer as a manual and as a text-book. We have access on the book-sellers' shelves to many volumes on special subjects, some of them possessing considerable merit, but students in a technical school, or young men working by themselves, cannot generally afford to purchase a small library and cull from a number of volumes. That we have no entirely satisfactory book is evidenced by the fact that most of the instruction on civil engineering, in our technical schools, on the theory and practice of construction, is given by lectures. Mahan's Engineering is largely descriptive; Rankine's Manual is eminently theoretical, and very comprehensive, but it is so condensed, and the author so frequently gives results and formulæ for application without the steps by which results are obtained from elementary principles, or if he gives the steps of an analysis they are so far apart, that the average student, if unassisted, can with difficulty pass from one to the other, and it is a very hard book to understand, although convenient for use when once understood. The range of the topics which he takes up is very large. Trautwine's Pocket-book has many merits and there is a great deal of valuable information within its covers. None of these, however, seem to fill the desired place.

One advantage of a book like Weisbach's Mechanics is that, owing to the detailed character of his investigations, one can take up the volume after a lapse of several years and refresh the mind upon any point without being obliged to work up a quantity of preliminary matter. Any engineer who has had occasion to look up some new problem, after a long period of work in some other line, will appreciate the advantage of this fact. The School of Roads and Bridges of France has had in course of publication for some four or five years a Manual for Engineers which, in some twenty parts, with accompanying plates, is supposed to cover about everything the young engineer ought to know. The work, if bound, makes some seven volumes of text, of about 500 pages each, and as many atlases of plates, the price, to the American purchaser, being from $120 to $150, and it costs more, therefore, than most engineers would desire to pay. The portions on building laws and such kindred matters would not, of course, be of interest to us.

What we need is a good, *sound* text-book which shall not require of the reader a preliminary knowledge of more than the general principles of statics and dynamics, with the simpler operations of calculus, and which shall give the matter that often is classed under Applied Mechanics, as also, in general, strength and resistance of materials, the theory of trusses and frames, earthwork and retaining walls, foundations, masonry, tunnels, waterworks, drainage, sewerage, etc. The author should seek the simplest demonstrations, draw from the practical experience of the field and workshop, introduce graphics, and bring out the latest discoveries and improvements.

We very much fear that we shall not get what we ask for; the work must be concise and at the same time clear, the labor and research required would be large, and the prospect of remuneration would be small. The sale of scientific books is too limited to encourage a hope for pecuniary profit from such a venture, and unless some one is moved to undertake it as a labor of love, we must be content to get our information and instruction from various authors and sources.

BURSTING OF THE STAFFORDVILLE DAM.

STAFFORD, Conn., March 27.—The dam of the Staffordville reservoir gave way this morning, causing in this village fearful damage. The following is a description of the dam and the surrounding country: The reservoir belonged to the Reservoir Company, owners of the mills on the stream below. The dam was raised six feet the past winter, and the storm last night filled it for the first time, Close by the reservoir stood the satinet mill of E. A. Converse; next the shoddy mill of Jacob Basch; then the machine shop of S. A Widen. Lower down was the Phœnix Manufacturing Co.'s cassimere mill at Hydeville, and three miles below the Glen mills cotton-warp factory stood at Glenville. The Converseville Manufacturing Company's cassimere mill and G. M. Ivess' Granite Mill for making cotton goods were on the stream at Stafford Springs, about five miles from the dam. The reservoir was about a mile and a quarter long, and averaged a quarter of a mile in width. The dam was about twenty feet high, but short, the stream bed being narrow for some distance below. The water is the head of the Willimantic river. Six years ago a dam on a tributary stream above here gave way, causing great damage. The only wire to Staffordville is owned by the New London Railroad Company.

After the correct particulars of the accident are ascertained we will publish them.

BOSTON SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Boston Society of Civil Engineers was held on the 21st inst., at Wesleyan Hall. The annual report stated that six members have been voted in during the year. Total active membership is now sixty-two. There are eighteen others delinquent for more than six months in the payment of assessments and admission fees for a total sum of $134. These persons are not now by the terms of the constitution members of the society. The treasurer reported a balance in the treasury of $703.39, while last year it was $403.39. The expenses for the year have been $251.72 Deducting some unusual expenses, the expenses for the year would have been $149.19, against $572.28 for the previous year. The following named officers were elected for the ensuing year: President—Thomas Doane; Vice President—Joseph P. Davis; Secretary—George S. Rice; Treasurer—Clemens Herschel; Librarian—E. K. Clark; Auditor—Henry Manley.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The April meeting will be held on Tuesday, April 3, at the Sherman House Club Rooms, beginning at 4 P. M. Gen. W. Sooy Smith will read a paper on "New Methods of Making Iron and Steel."

The Committee on the adoption of the Metric System, will present a final report for discussion.

The Secretary will announce the particulars concerning the trip to New Orleans to attend the Ninth Convention of the American Society. The necessary expenses will not exceed $4.00 per day. Members who desire to attend can obtain, from the Secretary, certificates that will entitle them to free R. R. transportation from Chicago to New Orleans and return.

L. P. MOREHOUSE, Secretary.

BRIDGE TRUSSES.

Editor ENGINEERING NEWS:

In your issue of December 16th, last, you published an article on "Bridge Designing," to which my attention was called by an article over the initials "A. H. M.," in your paper of January 6th, 1877. In reading your article I find (as did also, "A. H. M.,") that you did not follow the Stress of *compression* put, by you, upon the diagonal in the second panel *beyond that* panel, and you seemed to be satisfied that your declaration that "the tendency to produce compression in the second diagonal, will reduce the tension by just the amount of the compression, still leaving the piece under tension," was sufficient.

Beyond the second panel you leave us in doubt as to the route taken by the stress to the other end of the truss; hence you did *not answer* the "query put." "A. H. M." did answer the query, but not correctly. This is a very interesting subject to bridge builders, and to bridge designers, especially to those who are young, or new beginners in the business; hence I hope you will allow me space to express views, long entertained by me, and which I have not seen elsewhere stated, on this subject.

I will preface what I have to write, by a quotation from the late Dr. Whewell, and also write a few propositions, which should be kept in mind when designing and proportioning bridge trusses.

"There is no force, however great can stretch a cord, however fine, into a horizontal line that will be accurately straight."

From this quotation it is inferred that, a horizontal force, however great, cannot resist a vertical force however small, *and that horizontal members of bridge trusses cannot carry, or transfer longitudinally of the trusses vertical stresses or forces.*

Proposition 1st.—A figure without inclined members, does not represent a truss.

Proposition 2nd.—A frame without inclined members, that is, with horizontal and vertical members only, cannot carry any weight as a bridge.

Proposition 3rd.—Inclined members only, in bridge trusses, can carry, or transfer longitudinally of the trusses, *weight*, or the vertical components of *weight stresses.*

Proposition 4th.—Horizontal members, in bridge trusses, transfer horizontal stresses only, and not weight nor vertical components of weight stresses; hence they are not *carrying* members.

Proposition 5th.—Vertical members, in bridge trusses, transfer weight stresses, vertically only; hence they are not *carrying* members.

Proposition 6th.—In bridge trusses, stresses cannot pass *up* compressive members, nor *down* tensile members, that is, members prepared to receive those stresses only.

Proposition 7th.—No member in bridge trusses can be made to act equally well in two capacities—compressively and tensively, that is, as well as two members would, each acting in one capacity.

Proposition 8th.—In bridge trusses the two diagonals in any panel cannot be under stress, *from weight* at the same time, and as a corollary to this proposition, two stresses *occasioned by weight*, cannot pass in opposite directions, in any panel at the same time. This is the key to the subject under consideration.

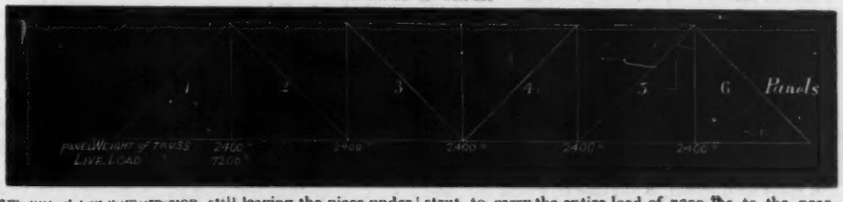
Proposition 9th.—If the *main* diagonals, in a bridge truss, are under stresses due to the weight of the bridge *only*; or if they are under stresses due to the weight of the bridge and load only, the *counter* diagonals cannot be under stress, or in action, and if the counter diagonals are brought into action to any amount of stress, or stresses, the stresses on the main diagonals will be increased beyond the stresses due to the weight of the bridge only, or beyond those due to the weight of the bridge and load only, as the case may be, to the extent of the stresses on the counter diagonals; but no more weight will be borne by the mains, than was carried by them before the counters were put under stress.

I will now endeavor to answer the "query put" in your issue of December 16th, to-wit: "If a live load of 7200 lbs. hangs by the first vertical, in what manner will one-sixth of it pass to the further abutment?"

We answer that one-sixth of *it* will not pass to the further abutment. There cannot any part of it pass through, or on, any of the members of the second panel. Two of the members are horizontal; hence cannot be carrying members—they are simply resisting members to horizontal stresses, and enable the inclined end post, or strut, to carry the entire load of 7200 lbs. to the nearest abutment, the same as would be done if the outer end of the upper chord of the second panel abutted against a vertical immovable wall, and the outer end of the lower chord of the first and second panels was attached securely to the same vertical wall, and with the diagonal in the second panel removed.

The third and last member in the second panel (the diagonal) is a tie, and besides it is under action tensively (or is supposed to be from the weight of the structure of 2,400 lbs. per panel): hence no part of the weight attached to or at the lower end of the first vertical, or

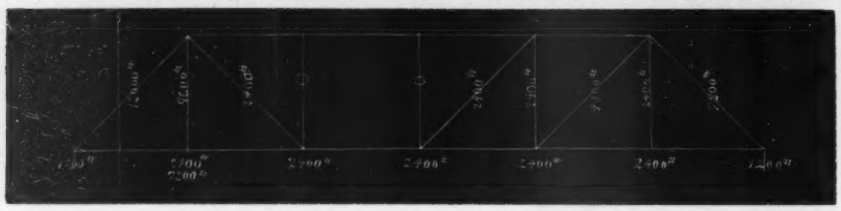
DIAGRAM OF TRUSS.



its equivalent in stress can pass *down* the diagonal in the second panel. As none of the three members of the second panel are capable of *carrying* any part of the weight through the length of the second panel, the entire weight, or its equivalent in stress, must pass *up* the vertical tie, and *down* the inclined strut to the nearest abutment—the most economical thing for it to do.

DIAGRAM OF TRUSS NOT LOADED.

DIAGRAM OF TRUSS WITH 7,200 lbs. PLACED AT THE FIRST PANEL POINT FROM THE NEARER ABUTMENT.



Now as I have disposed of the entire weight suspended by the first vertical, or the vertical stress of 7,200 lbs. occasioned by it, by carrying it to the nearest abutment, and inasmuch as a weight, or stress, equivalent to one-sixth of it must necessarily be borne, in addition to the weights of half the truss, by the farthest abutment, it is necessary that I should explain *how* that fact is brought about.

In order to simplify the question I will consider the truss, as represented, without counter diagonals, and it will hereafter be seen that they are unnecessary when only *one* panel point from the abutment is loaded with a live load, of the amount given. Considering the entire weight of 2,400 lbs. per panel (weight given) as belonging to *one* truss, it will readily be conceived that each of the diagonals, in the third and fourth panels, will have 1,200 lbs. of truss to carry, and while the truss is not loaded, the stresses due to these weights will pass up the ties and down the struts, or posts, until they arrive at the abutments. The weight of truss, carried by each of the diagonals in the second and fifth panels, is 2,400 lbs. exclusive of that due to the diagonals in the third and fourth panels, and altogether 3,600 lbs. of truss, is carried by each of the diagonals in the second and fifth panels.

Now when the live load is placed at the lower end of the first vertical, it occasions a horizontal stress in the top chord, which stress passes along the top chord until it reaches the upper end of the diagonal in the fourth panel. This horizontal stress releases the diagonals in the third panel entirely, and *compels* the diagonal in the fourth panel to *take up* and carry the entire panel load of 2,400 lbs. up the ties, and down the struts until it arrives at the further abutment.

It is the taking up and carrying of one-sixth of 7,200 lbs. *of truss*, that releases the diagonals in the second and third panels, and not compression as stated by you in your answer to the question, Dec. 16th last.

It happens, in this case, that one-sixth of the live load assumed to be placed at the first panel point, is just equal to a half panel weight of truss; hence where the diagonal in the fourth panel has taken up the 1,200 lbs. that belonged to the diagonal in the third panel (when the truss was not weighted with any live load, and hence was in equilibrium) that panel is *balanced* and needs no diagonal, in the case of a dead load, and disposed of as the live load is assumed to be.

I have now, I believe, answered the "query put" not literally perhaps, but in the sense of answering the querist.

It is not any part of the 7,200 lbs. that arrives at the further abutment, but it is an equivalent weight of truss, that is carried to that abutment.

In all cases of truss and arch bridges being unequally loaded near one end, the equilibrium of the entire weight of bridge and load is brought about, by the diagonals near the center of the bridge taking up, of the weight of the bridge, an amount equivalent to the amount of load that would be due to the further abutment, considering the position of the load relative to the abutments.

If this were not the case, the stresses due to the weight of the load would be passing in one direction, and those due to the weight of the structure itself, be in equilibrium, and be passing in the opposite direction at the same time, which I conceive to be *impossible*.

N. B. The figures on the inclined members are the *vertical components* of the stresses, and those on the verticals are the *stresses* on those members.

The panel, in the last diagram, without a diagonal, represents that no stresses are passing that panel, except horizontal stresses in the top and bottom members, and that the panel is in equilibrium. D. H. MORRISON.

DAYTON, OHIO, *March 2d, 1877.*

THE BROTHERHOOD OF LOCOMOTIVE ENGINEERS.

(*From the Nation.*)

As a practical result of their report on the strike of the Boston & Maine locomotive engineers, the Railroad Commissioners of Massachusetts contented themselves with recommending the passage of certain laws intended to guard the rights of the public in case any more strikes occurred. The community was to have the free and safe use of its railroads secured to it, no matter what quarrels might arise between employers and employed. This, of course, was as far as the Board could go, occupying the position it then did. Its members were not there to arbitrate or to suggest remedial measures looking to a removal of the root of difficulty. Their business was to act in such a way as to secure to the public the full and free enjoyments of its rights, and there, for the present at least, to stop. What was then to follow must, if it was to be of any value, result from careful investigation, and assume the shape of a thoroughly-matured plan.

One thing we do not hesitate to say, and it is a conclusion to which we believe not only all the leading railroad men of the country have come, but also every one who has given any thought to recent events—the Brotherhood of Locomotive Engineers has got to be broken up. In view of its course of late in connection with strikes, in which every right of the business and travelling public was brutally disregarded; in view of its avowed policy as defined in the recent threatening and almost incendiary speeches of its Chief Engineer, it is safe to say that its usefulness is wholly gone, and that it has become a mere common nuisance, the longer existence of which is a standing public menace. The only question is how to proceed so as to break it up most quietly and most effectually. It now numbers in its divisions nearly ninety per cent. of the experienced locomotive engineers of the country; they are bound together by a strong *esprit de corps*, and have an even inordinate faith in the really great power of their combination; the treasury of the order is well supplied, and its discipline, founded on a strong class feeling, is very effective. Altogether, it is a formidable opponent, one with which no railroad corporation would care to grapple if it could help it. Even if a strike fails, the cost of victory is something at which directors may well stand aghast. In the recent Boston and Maine strike, for instance, though the question practically at issue was whether the Brotherhood or the officials were to operate the road, it was nominally only a matter of $6.70 a day: if the officers of the road would have allowed ten cents a day increased pay to sixty-seven men, there would have been no strike. To do this, however, involved a submission to the Brotherhood, and injustice to some 1,500 other employees whose pay has also been reduced. The directors very properly, as we think, refused to yield, and the strike ensued. The corporation was completely victorious, but its victory cost it probably not less than $50,000, and possibly $100,000. On the other hand, to the Brotherhood the cost of the strike will probably not exceed $300 a day, or about two cents a day while it lasts, to each member of the order.

Under such circumstances as these the Brotherhood enters on every contest with the chances enormously in its favor. The larger and more unweildy its opponent the better. If they can but paralyze it for forty-eight hours they are sure of success. The road has got to be run; and if the corporation cannot rally from the knock-down blow and stagger to its legs at once it is lost. Accordingly Mr. Arthur has reduced the system to a science, the cardinal principle of which is instantaneous action with utter disregard of the public. A strike is secretly decided upon. Two hours, and two hours only, of notice is given, at the expiration of which every engineer stops his locomotive where it then is; stays by it two hours to give the corporation time to yield, and, if it does not, he blows out the boiler and abandons the train. Indeed, it is well if in so doing he does not take the locomotive with him. Then comes the short, sharp struggle. The road from end to end is blocked with abandoned trains, and the whole force, not only of the striking engineers but of the brotherhood, is directed to keep it so. In the case of the Grand Trunk strike, the passenger trains were stopped, amid Canada's December snow and ice, at 11 o'clock at night; locomotives were disabled, tracks obstructed, and those who undertook to work the abandoned engines were mobbed. Grand Chief-Engineer Arthur was dealing with "the enemy," and the unfortunate passengers happened to come between him and it; for what ensued he did not hold himself responsible. Like the Prince of Denmark, he doubtless thought that

> "'Tis dangerous when the baser nature comes
> Betweeen the pass and fell incensed points
> Of mighty opposites."

In the case of the Boston & Maine road the tactics were exactly the same; fortunately the circumstances were different. The corporation by a desperate effort succeeded in mustering enough men who could not be frightened, and did not care to be bought, to enable it to keep a few trains in motion during the two decisive days. To one of these men $1,500 in cash was offered, if he would leave his engine; another was assaulted and beaten; all of them were cajoled and coaxed, or jeered at, threatened and insulted from one end of the road to the other. In two days the company had caught its breath; in four days it was master of the situation. At first, however, the chances were four out of five against it; and each of those days cost it tens of thousands of dollars.

Whose turn comes next?—This is a question we have reasons to know is now exercising the minds of nearly every railroad president and superintendent—except those of the Boston & Maine and the Pennsylvania Company—in the country. These officers all know perfectly well that the majority of their engineers are members of the Brotherhood; that, as such, they cannot be relied on; and that the presence of Chief-Engineer Arthur in their ante-rooms means simply submission or fight. Of course, such a condition of affairs cannot last. It means anarchy. The only question is, how can the engineers be gotten away from the Brotherhood? Had any steps been taken to carry into effect Mr. Arthur's threat of a general strike on the Boston roads, in aid of the Brotherhood's waning fortunes on the Boston & Maine, we have understood that it would have been immediately met by the introduction into the Legislature of a law forbidding any corporation, under heavy penalties, to entrust a locomotive to a member of the Brotherhood. Such a measure, based on the principle that these men recognized an allegiance higher than the law of the State, and could not be relied upon not to abandon trains full of passengers in dangerous positions,

was, we have understood, drafted and ready for immediate submission. Practically, its passage would have broken up the Brotherhood in Massachusetts, as its members would have had to choose between leaving the order or seeking employment out of the State. Mr. Arthur, however, paused in time, and did not provoke this violent remedy. It was a measure, also, not likely to pass a State Legislature except under circumstances which are not now likely to occur, since Mr. Arthur has been taught a little discretion.

But this is a question which ought to be settled by the railroad corporations, and not by State legislatures. Indeed, it can never be properly settled on a basis of penal legislation; it must be made a matter of kindly and friendly adjustment between the employers and employed. The proper course to pursue is always a very simple one, and one which we wonder some of our rich and powerful corporations have not already adopted. They should constitute their own benevolent and life-assurance associations for the benefit of their employees. They should not leave this work to trades-unions; to do so, and thus invite outside influence, is neither sound policy nor good economy. Take, for instance, the Boston & Maine road. It had in its employ at the time of the strike 1,556 persons, of whom 67 were locomotive engineers. Had all of these been bound together in one Boston & Maine Benevolent and Life-Assurance Association, into which a percentage of monthly wages was regularly paid, no strike could have taken place. All occupations connected with running a railroad are hazardous. Both life and limb are in continual danger. Our railroad corporations are now old enough, large enough, and rich enough to take this into consideration, and systematically provide for it. The eight roads, for instance, running out of Boston, all of which only a few days since were in imminent danger of a combined strike, represent a permanent investment of $100,000,000, with the annual income of $20,000,000, and with 12,500 persons in their employ. The Boston and Albany alone employs 4,500. And these enormous corporations let trades-unions steal their men away from them! The thing seems hardly credible, and yet it is so. Plainly, therefore, it is wholly their own fault if the officers of these corporations stand in terror of Mr. Arthur and his Brotherhood. It is not legislation, but wisdom that they need. They have no business to call for penal statutes, or to look to the Government for protection. Let them protect themselves.

The Brotherhood of Locomotive Engineers is, therefore, as we look at it, now engaged in its last and most useful work. It is driving our larger corporations into creating brotherhoods of their own, turning their present mobs of employees into a regular graded service, with its promotions, its life insurance, and its pensions. The men would then be tied to the corporations by something more than the payment of monthly wages; nor would they lightly sacrifice by joining in strikes what represented the accumulation of years of service. It is no part of our business to work out the details of such a scheme. We can only say that what Mr. Arthur and his associates have done, we believe that Mr. Vanderbilt or Mr. Scott or Mr. Chapin can do a great deal better. Perhaps, however, in the whole railroad connection there is no man so well calculated or in such an excellent position to mature successfully the desired system as President Hinckley, of the Philadelphia, Wilmington & Baltimore. It wholly rests in the power of these gentlemen to destroy the Brotherhood they now dread so much. If a few more strikes are necessary to start them in the work, we sincerely hope that Grand Chief Arthur may, with as little delay as possible, supply the needed incentive.

ON THE PROBABLE ERRORS OF LEVELING; WITH RULES FOR THE TREATMENT OF ACCUMULATED ERRORS.*

BY WILFRED AIRY, B. A., M. INST. C. E.

As the members of the Institution are no doubt familiar with the processes of leveling, it is not intended to do more than glance at the various precautions taken to provide against accidental errors. In most engineering works it is unnecessary to give much attention to the small discrepancies between the results arrived at by different observers; but in the case of a complicated system of long lines of leveling, such as is required for the levels of an entire country, the aggregation of small errors becomes formidable, and the proper treatment of them requires considerable method and skill. In the present paper the author has dealt with errors of leveling under the following heads:—

A. The different classes of errors which occur in all leveling operations.

B. The probable errors of leveling on ground of different degrees of inclination, as deduced from standard leveling in different countries.

C. The treatment of probable errors in the case of a complex system of leveled lines.

D. Remarks on the instruments and methods of working used in accurate leveling.

A. The Different Classes of Errors which occur in all Leveling Operations.

These are of three kinds, viz.:—

(1) Mistakes.

(2) Instrumental errors.

(3) Errors of observation.

The first two of these are not of the nature of graduated errors. "Mistakes" arise from want of care in reading the staff, or the bubble, or in booking the readings; as well as from the foot of the staff being shifted between the readings, and from want of care in holding the staff vertical. The only effectual safeguard is to check the work throughout by independent observers, and to divide the distance into short sections defined by benchmarks. As a check on individual leveling, it has been customary in Great Britain and in India to graduate the staves differently on the two sides, and always to read both sides of the staff: the readings of the two sides ought, of course, to differ always by a constant quantity. To secure the foot of the staff from being shifted between the readings, it is usual to place the staff either upon a peg driven into the ground, or upon a three-cornered iron shoe jammed down firmly on the ground. To insure, as far as possible, the verticality of the staves, it is usual to have small levels, or plummets, let into them at one side, and in India the staves were guyed upright by ropes.

(2) Instrumental errors are either errors of collimation, of level, or of form of the telescope, the last-mentioned only coming into question when the spirit-level is not permanently attached. None of these will affect the accuracy of the leveling, so long as the instrument is always placed exactly midway between the staves: this condition is essential to all exact leveling, and has been observed in all operations of a standard character. Along with instrumental errors must be classed those of length and graduation of the staves: in general the graduation of the staves is very uniform, but errors of absolute length are not uncommon, and in all exact operations a standard bar should be kept at hand for testing the length of the staves.

(3) Errors of observation are the small graduated errors inseparable from all operations which depend upon human nerves and judgment. For any single operation they are very small; but, as they are repeated with every operation, they may amount to a considerable aggregate at the termination of a long course of work. For different persons the errors will, in all probability, have different values, as they depend upon natural and acquired keenness of estimation. They are, in fact, due to the degree of uncertainty existing in the mind of the observer as to the exact value of the several quantities which he has to estimate, and it is to be presumed that his estimate of these quantities is as likely to exceed as to fall short of the true value. Errors of judgment (but not 'mistakes') also occur in reading the staves, and the bubble; and errors also arise from small oscillations of the staves from the vertical, but not from carelessness or any determined bias on the part of the staff-holder. To these must be added slight alterations in length of the staves caused by changes of temperature or moisture: which, though sensible in amount, were found in the Swiss leveling to be very slow, small, and irregular, so that no law could be safely deduced. The combination of these produces the final error, and it is with these that the present paper is chiefly intended to deal. There is no safeguard against errors of observation, but their amount may be reduced by the selection of observers of natural quickness of sight and decision, well trained to the work.

Dr. Whewell and Colonel Walker have noticed that, in general, the results of leveling any given line differ considerably according as the line is leveled in one direction or the other. Colonel Walker attributes this mainly to the disleveling effect of the sun's heat upon the instruments, and to errors of reading the bubble caused by the oblique direction in which the light falls upon it. To obtain reliable results it is essential that every line should be leveled both ways, and the mean of the results adopted as the true value, as the various circumstances of heat, light, ground, weather, and indeed everything, would stand a chance of being reversed or modified.

B. The Probable Errors of Leveling on Ground of Different Degrees of Inclination, as deduced from Standard Leveling in different Countries.

In general the results obtained by different observers on a long line of leveling are different. But there are not unfrequently cases, even on very long lines and on steep ground, in which the results of the different observers agree closely, and it is usual to quote such close agreement as a proof of the accuracy of the common result. Nevertheless, it is always highly probable that the result arrived at is incorrect: for no observer could reckon on arriving at the same result each time, if he re-leveled the section several times over, and yet he would probably be unable to say that one result was more correct than another. Therefore the chances are greatly against the probability of the common result being correct, and it may be assumed that the result is in error, but that the errors of the different observers have all run in the same direction, and are of equal amount.

Since then it would be quite unsafe to form conclusions as to the probable error of the leveling on any line from the actual discordance of the observations on that particular line, and since it is necessary to be furnished with values of the probable errors in order to combine the results on different lines in the most probable manner, it becomes necessary to form rules or tables for arriving at the probable errors either by calculation or inspection. This subject has received much consideration from Messrs. Hirsch and Plantamour at pages 108–121 of the "Nivellement de la Suisse."

Obviously the amount of the error on any given line will, in general, depend upon the length of the line and the steepness of the ground. If length of line only were considered as affecting the error, and (e) be taken to represent the amount of the error which may be admitted as fairly due to a single mile of the leveling, then the probable error on a line of length (k) miles will be $e\sqrt{k}$ (See Airy's "Theory of Errors of Observation," art. 53). But when there is much difference in the nature of the ground, it is certain that the error for any line will greatly depend upon the sum of the ups and downs on that line. Errors in the lengths of the staves and in small oscillations of the staves will certainly be proportional to the sum of the ups and downs: also, in all probability, steep ground will lead to high elevations where the effect of the wind and rain will be more severely felt, and the uncertainty of the readings will in consequence be greater. If the sum of the ups and downs only were considered as affecting the error, and (f) be taken to represent the amount of the error which may be admitted as due to a rise or fall of 1 foot, then the probable error on any line will be (f) times the sum of the ups and downs on that line.

In the application of these formulæ to the case of a 'polygon,' Messrs. Hirsch and Plantamour have apparently made no attempt to combine their effects. They have deduced the values of (e) and (f) from the closing error of the polygon, by assuming that the closing error is uniformly distributed over the entire length of the polygon, and have applied either one or other of the formulæ to determine the corrections to the several sides of the polygon, as a first approximation. Then if, as was usually the case, some of the sides of the polygon, went to form adjacent polygons, new values were ascertained for the corrections to those common sides from similar operations with the adjacent polygons. These new values were then imported into the original polygon, and a new closing error obtained for that polygon, from which in the same way as before second approximations to the values to the several sides were established. And a similar method was pursued for third and fourth approximations.

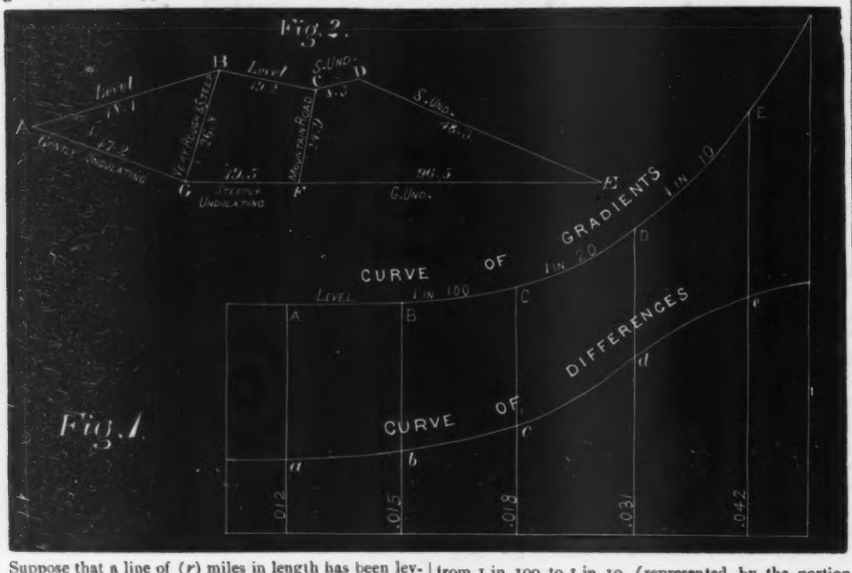
This plan appears open to several objections. First

*From the Proceedings of the Institution of Civil Engineers, London.

it is certain that the error due to any given line depends both upon the length of the line and the contour of the ground, and whatever formula is used for the corrections should have regard to both. Secondly, it is very unsafe to use the actual closing error of a polygon as the basis of the corrections which are to be applied to the several sides: for it might well happen that the closing error was exceedingly small, while the error at intermediate points was large. Thirdly, the method of successive approximations, as described, is laborious and unsatisfactory. As soon as any network of lines has been completely leveled, no matter how complicated it may be, there is no difficulty in applying the Theory of Probable Errors so as to obtain directly and simultaneously the most probable values for the levels of all the points of the system.

In considering the question of dealing, in a satisfactory way, with the adjustment of the levels on a complicated system, it occurred to the author to frame Tables of Probable Errors, such as would be applicable to the circumstances of the different lines of the system. The data for framing such tables would be drawn from the official records of standard leveling in different countries, and the value of the tables when framed would depend in a great degree upon the mass of statistics reduced in order to compile them. Through the courtesy of Colonel Clarke, R. E., of the Ordnance Survey Department, and of Colonel Walker, of the Survey Department of India, the author has obtained access to the original records of the check leveling executed on long lines in Great Britain and in India, and he has extracted similar information with reference to the Swiss leveling from the "Nivellement de la Suisse."

A critical examination of the discrepancies between observers on the same line of levels, showed that the average amount of the discrepancies depended very much upon the inclination of the ground. If the average inclination between two benchmarks was steep, no matter whether parts of the distance were uphill and other parts downhill, then the discrepancy was greater for that section than for another section on which the ground was flatter, and this rule was found to hold with great regularity. It was therefore possible to frame a Table of Errors suitable to different inclinations of ground, and the application of the table is as follows:



Suppose that a line of (r) miles in length has been leveled, and that the character of the ground corresponds with one or other of the classes mentioned in the Table. The probable error due to a single mile of leveling on such ground would be taken from the Table by simple inspection, and this probable error multiplied by $\sqrt{r}$ would give the probable error due to the whole line. By this method due account would be taken of all the principal causes of error, as depending upon the contour of the ground and the length of the line, and the probable error for each line of the system would be determined on a broad and uniform basis.

The results of the reduction of a large mass of observations in Great Britain, India, and Switzerland are given in Table I. There appeared to be no practical advantage in quoting the average differences for very small changes of inclination of the ground, and the differences are therefore given for the gradients included between broad and well-defined limits of inclination. Whenever the differences were tested for gradients not quoted, the law of increase of differences with increase of inclination was observed to hold good with considerable uniformity. Thus, for instance, in the English leveling the average differences in a single mile were—

	Foot.
For gradients below 1 in 100	0.024
Do. between 1 in 100 and 1 in 50	0.035
Do. do. 1 in 50 and 1 in 20	0.042

TABLE I.—AVERAGE DIFFERENCES in a SINGLE MILE of the RESULTS OBTAINED by TWO OBSERVERS on GROUND of DIFFERENT DEGREES of INCLINATION in GREAT BRITAIN, INDIA, and SWITZERLAND.*

	Great Britain.	India.	Switzerland.
	foot.	foot.	foot.
(1) Average difference in a single mile on ground nearly level, and in very favorable circumstances of weather	**.0230**	**.0142**	.0125
(2) Average difference in a single mile on ground of a slightly undulating character, where the gradients do not exceed 1 in 100	.0238	.0168	.0148
(3) Average difference in a single mile on ground where the gradients lie entirely between 1 in 100 and 1 in 20	.0379	**.0208**	.0183
(4) Average difference in a single mile on ground where the gradients lie entirely between 1 in 20 and one in 10	**.0566**	**.0350**	.0308
(5) Average difference in a single mile on steep and rough ground where the gradients are frequently steeper than 1 in 10	..	..	.0416

*The quantities marked in black figures are estimated from the analogy afforded by the Swiss Leveling, as no direct data could be furnished.

To exhibit more clearly the nature of the law which regulates the magnitude of errors in leveling, the author has prepared a diagram [Fig. 1], in which the successive changes of gradient from 'level' to upwards of 1 in 10 are represented by a curve of gradients, and the corresponding magnitudes of 'differences' by a curve plotted from the observed results of the Swiss Leveling. Such a diagram may be usefully applied to obtain the probable difference of results on ground of variable character. Thus, for instance, if the gradients on a given line range from 1 in 100 to 1 in 10 (represented by the portion B C D E of the upper curve) in about equal proportions, the probable difference of results might be taken pretty correctly by inspection from the corresponding portion, *b c d e*, of the lower curve. But the inspection method will not be quite accurate, and it may be convenient to form accurately a table which would be applicable to most circumstances of leveling.

[*To be continued.*]

IMPROVEMENT OF NAVIGABLE RIVERS.

The Illinois House, on the 1st inst., adopted the following resolutions relative to the improvement of navigable waters (especially rivers) in this State. The Senate, recently amended the first section of the preamble by striking out the words therein relating to injudicious expenditures of the Government funds, and adopted the resolutions:

WHEREAS, The Mississippi Valley has heretofore received from the general Government but meagre appropriations for the improvement of its rivers and harbors, and these small appropriations have been for the most part injudiciously expended; and

WHEREAS, The Mississippi Valley and its slopes produce the great bulk of the agricultural surplus of the country, and the producing class of our people have been and still are compelled to ship the products of their industries to tide-water over expensive lines of railways, at a cost of 20 per cent. of the gross value of such products, a tribute they can illy afford to pay monopolists, and from which they of right ought to be protected by the general Government; and

WHEREAS, If the navigation of the Mississippi river and its tributaries should be improved by the judicious expenditure of liberal appropriations made by Congress, our surplus products could reach tide-water by way of New Orleans at a cost of 6 per cent. of their gross value, saving to the Western producers 14 per cent. of the gross value of the products to their industries, which they would lose if compelled to reach tide-water through unnatural channels; and

WHEREAS, By means of the first liberal appropriation made by Congress for the removal of obstructions to the navigation of these Western rivers, the mouth of the Mississippi has been successfully opened to commerce, but the benefits resulting from the consummation of the great enterprise can only be partially enjoyed by the inhabitants of the slopes and valley of the Mississippi unless their means of egress be facilitated by improving the navigation of these Western rivers; and

WHEREAS, By judiciously expended appropriations commensurable with the benefits which would result therefrom, the channel of the Mississippi river between the mouth of the Missouri and the Gulf of Mexico might be shortened nearly 200 miles, by which, together with the removal of the bars which retard the velocity of the current, this great stream might be subdued, and the immense adjacent territories of productiveness, now worthless from annual inundations and resulting malaria, might be reclaimed and utilized; therefore, be it

Resolved by the House of Representatives, the Senate concurring herein, That the Congress of the United States be, and is hereby, memorialized to make just, liberal, and sufficient appropriations for the permanent improvement of the navigation of the Mississippi river and its tributaries, and their harbors; and in the expenditure of any money which may be so appropriated, and in all contracts for such river and harbor improvements, that Congress adopt like rules and stipulations as in the contract with Captain Eads, by the act of Congress approved March 3, 1875.

Resolved, That the Governor is hereby requested to transmit a copy of this memorial and these resolutions to the Governors of Wisconsin, Minnesota, Iowa, Missouri, Arkansas, Louisiana, Mississippi, Tennessee, Kentucky, Indiana and Ohio, and request the co-operation of their Legislatures in advocacy of this memorial and resolutions.

Resolved, That this memorial and resolutions be transmitted through the proper channels to the Senate and House of Representatives of the United States.

DISCUSSION ON HOUSE DRAINAGE.

At the meeting of the "New Haven Engineering Society," held at North Sheffield Hall recently, a paper on the subject of House Drainage was read by City Surveyor, Charles E. Fowler, from which the following abstract is made:

The subject of House Drainage is one that is not as familiar to the general public as its importance deserves. Under this method is treated the most approved method of laying the drains, and the proper arrangement for their ventilation. As a general thing, in our own and in other cities, the work and arrangement of house drains is faulty, both in design and execution. It is not claimed that it is intentionally so, but simply for the reason that the matter is not thoroughly understood. The common plan or arrangement of a house drain as usually carried out here, was to carry the connection from the sewer or cesspool to some convenient point under the cellar bottom, and there connected with the soil and waste pipes from the closets, bath-tubs, sinks, bowls, etc., on the floors above. Usually at each inlet to the soil or waste-pipe, there is placed some kind of a water trap, although not always done. Between the house and the sewer or cesspool there should *always* be placed a proper trap, yet the statement was ventured, that of all the dwelling houses in this city that have drain pipes leading from the interior of the house to the sewer or cesspool, not one-fourth of the number have traps so arranged. This is a very strong statement, and reflects very discreditably upon the intelligence of our citizens; still it is believed to be true. With a house so constructed the result would be a free and unobstructed channel for the foul, impure or offensive air of the sewer or cesspool, to rise in the pipes to the interior of the house, and seeking escape at every crack and opening. And escape it would, for it is al-

most impossible to make and keep the interior drain pipes air-tight. The exposure of the pipes to the difference in the temperature of the atmosphere on the outside and of fluids on the inside, causes contraction and expansion, and rendering almost certain the breaking of the cement or filling of the joints of the pipes.

The air which is found in our sewers and in cesspools is hardly such as we would desire to have in our dwellings, and very often it is absolutely dangerous to health. It is believed that there is more danger from the air found in cesspools than in sewers, for in the latter there is circulation and better opportunity for purification. But in either case, for the safety of our lives, its entrance into houses should be prohibited. The air from sewers or cesspools may escape very freely in our dwellings before its presence will be suspected, and that this happens very often there can be no sort of doubt. A large amount of water thrown into the soil or drain pipe will, in most cases, empty the small traps at the sinks and bowls of the house, unless there is some provision for admitting air at the upper end. In cases where there is a trap located between the house and the sewer or the cesspool, in addition to the traps at the inlets to the drain, there is another danger that is often overlooked, and that is from the air which may be confined in the drain and soil pipes themselves.

This air, like that of cesspools and for the same reasons, is considered more detrimental to health than that found in the sewers. Whenever a large amount of water is thrown into the pipes a certain amount of air must escape, and it is reasonable to suppose that air confined in such quarters would be impure and unwholesome. If no ventilation or escape pipe has been provided, this air will force the traps at the bowls, etc., where it meets the least resistance. If any portion of the soil or drain pipe is defective or leaky, the foul air will escape at such times, if at no other. Such is the case in many houses in this city, and it is known that many cases of sickness and perhaps death, have been caused by the neglect or carelessness of the owners, builders or designers of our dwelling houses. The remedy for these defects is deemed to be easy of solution and of practical application. The drain pipe, soil pipe, branches and all connections *must* be made air-tight, and all reasonable means taken for keeping them so. At every inlet should be located a proper trap. From a point just back of this trap a pipe must be carried up from the drain to the surface of the ground, and there connected with a leader or rain-water spout from the roof. The soil pipe inside the house must be carried up its full size to a point above the roof, as a ventilating shaft. Experience has shown that owing to the warmer atmosphere of the houses, and the consequent heating of the internal pipes, that there is a constant circulation of air through the pipes—coming down the outside pipe and passing up the soil and ventilating pipe—which cannot be otherwise than of great benefit as a purifying agent. Communication should also be established between the ventilating shaft or pipe, and all parts of the branch pipes where there is any danger to be apprehended from confined or stagnant air, bringing the air circulation as near as possible to every trap on the premises. By this arrangement, all stagnation is prevented, the pipes are constantly exposed to the purifying influence of currents of air, and the water-traps throughout the house are relieved from pressure, both of the pent-up air on the one side and the atmospheric pressure on the other.

A number of well-known authorities on the subject were quoted, and explanations of the plan were given by illustrations. Quite a lengthy discussion followed which was participated in by Professors Brewer, Trowbridge, Norton and Newton, Dr. Lindsley, Messrs. Hill, Pierce, Kelly, Ferry and others of the society. The remarks of Prof. Brewer, president of the Board of Health, were especially interesting, and he related several instances of defective workmanship and bad results that had come under his observation.

A MODEL NAIL MILL.

Among the most flourishing of the great industries of the iron regions of Pennsylvania and West Virginia which are now showing the effects of reviving trade, the celebrated Benwood Nail Works at Wheeling, W. Va. stand prominent. The old mill which was totally destroyed by fire nearly a year ago has been replaced by one of the finest Nail Mills in the world—a fire-proof building constructed solely of iron, fire-brick and stone, unsurpassed for excellence of plant and convenience for the purposes designed for by any similar factory in the country. The following we extract from the *Wheeling Sunday Leader* of March 11th:

Below the forge, which is 94 by 116 feet, sixteen puddling furnaces are in operation in a building measuring 75 by 177 feet, and 14 more will shortly be set at work in a building 100 by 62. These furnaces are all new and are constructed upon the latest and most improved models. The coal that supplies these furnaces is dug out of mines owned by the company, and which are but a few rods away. The cars are filled in the mines and run on a short incline to the elevated railway that runs around the whole mill and close to the walls. It is then dumped at the feet of the furnaces and the great desideratum of cheap coal is attained with the least modicum of expense.

At the upper end of the puddling department and separating it from the heating department are the mammoth engine of the main building and the eight boilers that supplies it and the engines in the machine shop, water works, and factory, with steam. Above are the muck rolls, shears and ore crusher. These are all combined in two departments measuring 57 by 146 feet and 156 by 75 feet. The main engine is considered a master piece of machinery and is 40 inches cylinder and 48 inches stroke. The boilers are all 28 feet long and 44 inches in diameter. To the left are the machine and blacksmith shops, and water works. The first is a splendidly appointed workshop containing the finest machinery and a small army of the best workmen to be had. The water works stand apart from any of the other buildings. Three immense tanks stand upon three solid towers about twenty feet in height. A large Cooper steam pump in a small building behind them keeps the tanks always full, while steam pipes during the winter season prevent the water from freezing. This water arrangement itself is quite an institution, which a small city might be proud to own.

But we leave this portion of the works and enter the nail factory. The only difference in construction we noticed here from other mills was in the great width of the factory. Our conductor expatiated on the latter advantage showing what an immense labor of handling is saved. A railway track surrounds the whole of the interior of the factory, and the nails are taken from under the machines, hand picked, placed in kegs, rolled on the small cars and are then stored in the factory along the walls, or else are run out to the door and shipped. From one of the doors of the factory an inclined tramway runs to the river. A branch track of the B. & O. R. R. also passes the doors, and whether the nails are to be shipped by rail or river the vessel is at the door, and hauling or extra handling entirely dispensed with.

The factory building is 120 feet wide and 300 feet in length. It contains 110 nail machines at present and a number more are soon to be added.

By the courtesy of Major. Loring, we were permitted to make minute inspection of every department of this magnificent establishment, and we were much impressed with the system upon which the whole was planned.

From the first processes through which the iron is passed until it is loaded on the boat or cars every department seems managed upon a system that is perfect in itself and harmonious to all the rest. Every device that can save time, labor or trouble, is placed just in the right spot and the aggregate work done by them must result in an immense saving to the company each year and enable it to put the very best quality of nails on the market at the closest margins.

The Benwood mill now occupies about two acres of ground. Situated upon a bold bluff of the Ohio river, about two miles below Wheeling, and with inexhaustible supplies of fuel, and unsurpassed shipping facilities we look to see it in time become one of the largest and most important manufacturing establishments in the world. It is under the management of splendid business men, whose experience in the nail business is ripe and valuable.

CORRESPONDENCE.

PAWTUCKET, R. I., *March 24, 1877.*

Editor ENGINEERING NEWS:

SIR.—I have read and tried several of the forms for keeping levels recommended in your paper, and think for accuracy and convenience of work, that recommended by Mr. Davis is far the best, especially in convenience, as in cold or damp weather, when leveling for profile work I am obliged to reckon on the field only the Bench Marks or T. P. and not even then unless transferring heights for marking, as I note in the intermediate readings as read by the Rod-man and do the reckoning in the office. Respectfully yours,

A. R. SWEET

REDUCTION OF LEVEL NOTES.

OTTAWA, *March, 17, 1877.*

Editor ENGINEERING NEWS:

SIR.—In your issue of 10th inst. is a letter from Mr. J. B. Davis on this subject, in which he refers to my former letter.

I hope neither he nor any of your readers will take my remarks as disparaging the American system. I have always used it, since I came to Canada, on account of its quickness in field work. By this system there should be no excuse for a leveler not having his levels reduced in the field. There is only one operation needed, and this can be done while the rodman is moving from station to station.

Levels can be reduced in the field by the English system, but the greater amount of calculation may interfere with the extent of the day's work. For this purpose, only back and fore sights need be made up as Mr. Davis suggests.

Mr. Davis does not meet my argument, that an error at an intermediate point, cannot be discovered at the time. For example, suppose that the elevation of station 26 had been reduced 106.13, instead of 104.13, the error could not have been discovered before the instrument was lifted, whereas by the English mode it would have been found out at the fore sight, thus

back sight	2.619
fore sight	7.695
difference	5.076
Elevation of B. M.	106.287
Elevation station 29	103.211
difference	3.076

showing at once a difference or error in reduction of 2 feet. This the leveler would discover at once, when taking the difference between his back and fore sights, before lifting his level. No experienced leveler would think of lifting his level until he had applied the check, which is a check on the reduction as well as on the fore sight reading.

I always apply the back and fore sight-check, after reducing from "height of instrument," at every move.

The reduced levels ought to be checked in the office by the English or Mr. LeBaron's mode, to check intemediates, especially in permanent levels.

I am glad to see Mr. Davis pointing out the importance of equalizing back and fore sights. Young levelers do not pay that attention to this point which it deserves. I have sometimes had much difficulty in impressing its importance upon beginners.

ALAN MACDOUGALL.

JERSEY CITY, N. J., *March 20, 1877.*

Editor ENGINEERING NEWS.

SIR.—I have used in my business for about fifteen years the method of keeping level notes given below, and as it may be of use to your readers, in view of the interest taken in the subject by some of your correspondents, I send you a copy of a page of one of my old note books.

I find that while the old method requires the use of two pages, if it is necessary to make extended remarks, by this method only one page of the note book is required.

By the use of the letters I and P the height of instr. and turning points are distinguished at a glance from the other values.

The column of stations is placed next to the column of values, for convenience in platting.

LEVELS ON HILLSIDE ROADS.

Obs.	Val.	Sta.	Remarks.
B. B.	110.98		Door sill of Copeland's grocery.
+ 0.89	111.87	I	
— 5.97	105.90		Curb S. W. cor, Palisave and Reservoir avenues.
— 6.48	105.39		Curb N. W. do do
— 6.18	105.69		Center do do
— 6.96	104.91		Curb E. side do cen. do
— 7.63	103.24	0	Center H. S. Road (stake.)
— 9.90	101.97	P	
× 1.76	103.73	I	
— 5.10	98.63	+75	" " "
—12.10	91.63	1	" " "
—11.39	92.44	+75	" " "
—13.45	90.28	2+19	" " "
—10.61	93.12	P	
+ 0.33	93.45	I	
— 6.00	87.45	3+5	" " "
— 7.50	85.95	4	" " "
— 7.22	86.23	P	
+ 1.55	87.78	I	
— 6.00	81.78	5	" " "
— 8.78	79.00	+50	" " "
—12.38	75.40		

LEVI W. POST.

COLUMBUS, O., *March 22, 1877.*

Editor ENGINEERING NEWS:

SIR.—As a contribution to the discussion between Messrs. Clemens Herschel, A. B. Hill, F. H. Smith, Alf. P. Boller, Chas. Bender and others, relative to the merits and defects of the different systems employed in the construction of iron bridges, it may not be out of place to hear the opinion of a man, whose authority on this subject is unquestioned in Germany, where his famous work on the "Theory and Calculation of Iron Roof and Bridge Constructions" is used as a text book in the best polytechnic schools of the country.

In the first chapter of this work, Professor August Ritter, of the polytechnic school at Hanover, Germany, says: "In the larger constructions of roofs and bridges, the proper and most economical distribution of the materials is the principal consideration; not only because the cost of the materials in such constructions is generally large, when compared with the cost of labor, but principally for the reason, that the applied material forms a dead load, upon which not unfrequently the practicability of the entire structure depends. A perfect construction should always fulfill these requirements: 'that everywhere the full capacity of resistance of the materials is employed, and that nowhere any superfluous material is expended.' These conditions may be otherwise stated in this form: 'All parts of the structure shall be able to bear the maximum of the admissable strain under the most unfavorable condition of the load.' With ends or bars, which are either subjected to extension or compression in the direction of their length, this condition is readily satisfied, because all parts of the cross section of such bars or rods are equally strained. With bars, however, whose resistance to flexure is brought into requisition, the above condition is never satisfied, because the strains resulting from

HIGHWAY AND RAILROAD BRIDGE, 250 FEET SPANS, ST. JOSEPH, MO. BY THE DETROIT BRIDGE AND IRON COMPANY.

flexure are always distributed unequally over the section of the bar. A good structure should therefore be composed, if possible, of members in which only longitudinal strains occur; never strains of flexure; in other words, of bars and struts subject to extension and compression.

"The tendency to conform to this general rule is becoming already quite apparent in practice; as larger structures are being undertaken, they approach more nearly to the standard above required.

"The desire to save material gradually led from the solid rectangular beam to I and II shaped cross sections, and the substitution of separate bars for solid plate, has finally led to the various combinations of bars and rods, in which only longitudinal strains occur. The iron roofs, and the lattice and truss bridges of the present day are samples of these constructions.

' 'In order to fully satisfy the above named conditions, it is necessary that the connections of the bars employed in a structure should be formed by simple connecting bolts; (hinges). Whenever, instead of the simple coupling bolt, which admits of the free rotation of the bar around its connecting point, a rigid connection is attempted by riveting, as is still the practice in many lattice and truss bridges, the object is always partially defeated, for the reason, that in all such cases transverse strains are inevitably added to the longitudinal strains.'

"Aside from the disadvantageous distribution of the material, such imperfectly constructed combinations suffer also from the more serious defect, that the determination of the actual maximum strains is more or less removed from control, while in all theoretically correct structures the strains of every member can be readily ascertained with the utmost accuracy. It is a noticable fact, that those constructions which approach nearest to the theoretical perfection are always those whose strains are the most easily determined."

After quoting the above authority it would be preposterous to add any individual views of my own.

To argue from the failure of the bridge at Ashtabula in favor of riveted structures and in condemnation of other connections, will now, in the light of recent testimony, no longer be considered admissable. That unhappy structure seems to have combined all the defects of all systems but had none of the good qualities of any system.

M. I. BECKER,
Chief Eng. P., C. & St. L. Ry. Co.

HENDERSON, KY., *March 22d, 1877.*

Editor ENGINEERING NEWS:

SIR—I write this for the benenfit of those of your readers who have not tried binding, and who desire to save their periodicals for future reference. It seems rather extravagant to pay as much for the binding of one's papers as for the papers themselves. With this feeling I undertook my own binding, and succeeded, much beyond my expectations. In two evenings I bound the three volumes of ENGINEERING NEWS, and two other volumes of periodicals. I find the binding quite strong and very neat. I use one of your your "reading cases" for the current year, and find it answers a good purpose in keeping the numbers neat and smooth and quite ready for binding. The method I adopted is as follows: If creased, dampen the papers and subject them to pressure. Between two shelves fasten vertically on the front edges four strings equal distances apart. Let the end strings be somewhat nearer together than the papers are long; bind with the first and last numbers a piece of stout manilla paper to serve as lids to the volume; lay last number on the lower shelf against the strings; place your hand around the strings and between the middle leaves of the paper; stick a needle with waxed thread through one of the end strings and through the paper and draw it through on the inside—opposite the next string, from the inside; stick the needle through the paper and through the string; draw it through from the outside; stick the needle through the same string and through the paper and draw it through from the inside; proceed as described to the end. Place the next number and proceed in like manner; and so on with the balance of the numbers; then unfasten the strings and cut them to say within three-fourths of an inch of the volume; with stiff flour paste smear well the back of the volume; take a strip of muslin wide enough to cover the back and lap say one and one-fourth inches over on the lids; paste the muslin well and apply it to the back of the volume, and over on the back edges of the lids; place the book under pressure before a fire to dry the paste; when completely dried, by means of a keen knife and steel, straight edge, trim the edges, and you will have a volume quite as well bound for your purposes as though you had paid a book binder $3.00 for binding it. It is done in quite a short time, and the odd work was to me quite interesting. As the patent medicine men say "try it."

A.

CHICAGO, *March 20, 1877.*

Editor ENGINEERING NEWS:

SIR.—As you seem to be interested in the question of the economy of heat in the steam engine, I shall continue my comments on G. W. P.'s statement, after making a few remarks on his last letter. About the pressure of the gases your readers may form their own opinion from what has been said; but I entirely differ from him when he says that "the change from heat to work *is not the question* that is generally understood." Now, do I again fail to interpret his first letter where he says that "among the studies of economy of heat in the steam engine," for I understand him to mean the economical conversion of heat into work. With me the only question is the economical change of heat into work by means of the steam engine.

Before returning to G. W. P.'s queries, I will quote a little from a book about superheaters. I find in "The Compound Engine," by A. Mallet. New York, 1874, page 7: "In 1834, Ernest Wollf [a German we infer from his name] took out a patent [No. 6,600] of an engine described as compound, as nowadays constructed. A part of the description of this patent reads as follows: 'it is sometimes useful to have between the cylinders an intermediate reservoir to regulate the pressure; this may be placed with advantage at the base of the chimney so as to maintain or raise the temperature and the pressure of the steam in its passage from one cylinder to the other.'"

Having said so much without touching the question in hand, I will commence where my last left off. The illustration of expanding the steam down to 200° of temperature was used as G. W. P. had used it and as it would serve to illustrate a point. No engine should be so constructed or so proportioned to its work as to expand its steam to 200° for the following reasons: if it is a high-pressure engine the pressure of the piston on the steam side, will be less than the pressure of the atmosphere on the exhaust side; so that there will be a partial vacuum holding the piston back until the exhaust port opens, when the air will rush in until the piston returns and expels it with the exhaust steam. If it is a condensing engine the heat of the exhaust steam should not be greater than 100° or 110°, the heat of the condenser and the waste water from the condenser; this comes as a natural consequence of expanding the steam in using it economically by expansion.

In regard to putting the steam into a superheater, how is this to do any good? The steam is to leave the large cylinder at a temperature of 200°; this will be something less than the pressure of the atmosphere; if the superheater should increase the pressure, then this would increase the back pressure in the exhaust to the same amount, so what is to be done with it to make it pay for all this complication of machinery?

The same trouble ensues if the heated gases are carried around the cylinder, as this would involve the carrying of flues to the engine, then around the cylinder and then back to the chimney; besides being in the way of doing anything to the engine, it would soon become so coated with soot that it would be of no value, or it would be of no value, or it would have to be swept once each day the same as the boiler flues, and carrying the gases through a flue containiug so many bends would require so much more chimney, that taking all things into consideratio, the saving would be too small to pay.

With regard to steam jackets, I only know of four engines that have been built in Chicago having them, and of these, two have not yet been started, and I do not think that there are more than six all told. I state these things as I intend to write you a letter on this subject.

C. W.

NOTES.

Rock Island wants an Opera House.

Story county, Iowa has a new Court House costing $70,000.

Quincy wants to try the merits of Nicholson pavements.

Independence, Iowa, recently voted $10,000 for a new School House.

LaCrosse, Wis., will erect a new $8,000 School House the coming season.

The Chicago Dredging & Dock Co. was incorporated March 27, 1877, with capital of $55,000.

The American Society of Civil Engineers will meet in its ninth annual convention at New Orleans April 24.

In excavating for city purposes in Denver, gold was found in paying quantities.

Egan, the architect for the Cook Co. Court House, has compromised his claim of $26,000 by accepting $15,000.

It is generally understood that a critical examination of the Lake Crib will soon be made, so as to learn the exact condition of the portion under water.

NOTES — (*Continued.*)

Three thousand joint stock companies have failed in England in the last seven years. Their total nominal capital was $1,500,000,000.

The iron mountains of Missouri, according to Prof. Waterhouse, contains enough ore above the surface to afford an annual supply of 4,000,000 tons for 200 years.

The estimated cost of the new Water Works at Burlington, Vt., is $50,000. The total expenses of the present system are $17,894 per year, and the receipts about $19,000.

The first suspension bridge in the United States is said to have been constructed by James Finley, over Jacob's creek, on the turnpike between Uniontown and Greensburg, Pa., in 1796.

The United States government has built a concrete wall at Minneapolis, Minn., for the protection of St. Anthony's Falls. The wall, which cost $900,000, is 1,875 feet long, 40 feet high, 7 feet wide at the base, and 4 feet at the top.

The city of Peoria has discovered that her Holly Water-Works are useless, and has voted in her Common Council to discard them and put in a Dean pump. The present machinery is very inadequate. Only five-inch streams can be thrown at once. There is great dissatisfaction among the business men at the whole Water-Works system.

The Department of Public Works, Chicago, has issued to James Kincaid an estimate of $226 for work on the substructure of the Milwaukee avenue viaduct. The total value of the work so far completed by Mr. Kincaid is $63,923. It is expected the viaduct will be in condition for travel by the first of next month. All that remains to be done is the putting up of the side rails.

All the anchorages of the Suspension Bridge, Niagara Falls, have been opened, and with the exception of the first one, have been found in good condition. The repairs that have to be done are now completed, and passenger traffic will be resumed as soon as a certificate of the safety of the bridge can be obtained from three of the most able engineers of the day.

After much waiting and preliminary the Baldwin Hotel, San Francisco, Cal., is open. The inaugural ceremonies included a supper and grand illumination of the immense building at night. Mr. Chadwick, once of Willard's, Washington, is manager, and Mr. E. J. Baldwin, Pacific coast millionaire, owner and proprietor. The hotel and furniture cost about $3,500,000.

The London Stock Exchange dates from the South Sea bubble, and was in its origin an association for the protection of dealers in stocks, who were gamblers in the eye of the English law. A motion has been brought before Parliament for a Royal Commission to enquire into its "origin, object, present constitution, customs, and usages."

Says an Eastern writer: "Contracts for several new hotels have been awarded in Paris, all of which are to be finished in time for the great exhibition next year. French architects have been sent to this country to get ideas and plans, and it is more than probable that some of the new caravansaries will have American proprietors or managers. It seems to be tolerably well understood abroad that Brother Jonathan knows how to keep a hotel."

Advices from the International Commission of European engineers and scientists, now engaged in actual survey of the proposed Darien route for a ship canal connecting the Atlantic and Pacific, say they will complete the work about the 1st of April. They also indicate that they have found the low pass hitherto rumored to exist, within the State of Panama and will report in favor of that route as much more favorable than any others hitherto examined by any engineers.

There is great hope for iron manufacturers and locomotive builders in what is going on in the Southern Hemisphere, particularly in Australia and Brazil. The need of railways in Australia has been seriously felt, and in South Australia alone the Government proposes to spend $10,000,000 in constructing them. Nearly 100 lines of railroad are now building or under survey in Brazil, and in this country, as well as in Australia, American rails and rolling stock are in high favor. Orders for locomotives for Australia have recently been received in Paterson, N. J., while Russia, also, has ordered a number of cast iron car wheels for trial on the road from Moscow to Odessa.

The excitement in Essex county, Massachusetts, over mining is very great. Several new mines are to be opened, and one at Amesbury is soon to be vigorously worked. At Merrimack a shaft has already been sunk 250 feet, and there are five levels, with indications of an immense amount of vein matter still below and beyond and the quantity in sight is estimated at 400,000 tons, besides a rich deposit of gray copper discovered. Several veins of quartz were recently encountered, which are found to assay $20 to $25 per ton in gold and silver. All the land-owners in the region have already grown wealthy in anticipation.

At the meeting of the trustees of the Cincinnati Southern Railroad, held recently, the contract for the construction of the bridge across the Tennessee river was awarded to Clark, Reeves & Co., of Philadelphia, over six other competitors. The contract price is $117,000. The bridge will be an iron Whipple truss bridge, 1,804 feet long, and will cross the river in Hamilton county, about five miles northeast of Chattanooga, near Boyce's station. The superstructure will rest on eight piers and the abutments on either side. A draw, to be operated by hand and steam, will form the third span from the north end of the bridge, the round pier being 612 feet from the north shore. The distance from low water mark to the top of the cross ties will be 64 feet. The contract calls for the completion of the work by the 1st of January, 1878.

The second test of the West Side Pumping Works engines, of this city, has not yet been made, partly because the builders of the engines have not completed all arrangements for the test, and partly because the city is in no hurry to have it made. Preparations are being made slowly. If the test about to be made fails to show that the engines are capable of the specified "duty"—90,000,000 foot pounds—and the builders desire any further trial, they will be obliged to pay for it. The city has, already stood a $6,000 expense for the first trial, and will pay the cost of the second, but will go no further, demanding a settlement upon the showing of the last test. City-Engineer Chesbrough, when spoken to about the probability of the success of the trial, said that he would not be surprised if the 90,000,000 power were shown, because he had known instances where tests made after an engine had been in operation for a year had developed a much larger duty than those made shortly after the engines had been constructed.

The constitution of Illinois at present allows the General Assembly to pass laws permitting the owners or occupants of lands to construct drains and ditches for agricultural purposes across the lands of others, but makes no provision for the payment of the expenses of such drainage, except by voluntary contributions. An amendment which is to be submitted to the Legislature provides that the General Assembly may establish drainage districts and give to the persons placed in charge of such districts the power to construct and maintain drains and ditches, and pay the expenses of the same by special assessments on the lands benefited In several parts of the State, notably in the east and south, there are large tracts of lands which at the present time are substantially worthless, but which, if drained, would produce good crops. The amendment is one which is not likely to meet with any opposition, and the only regret is that it is necessary to delay the enactment of a law for the benefit of owners of such lands until the constitutional amendment has been adopted by the people.

It is stated that the Board of Army Engineers, consisting of Generals Duane, Wright and Gilmore, who were ordered to examine the Washington Monument and the foundation upon which it is bullt, after a careful examination of the work already done, in examining the strata beneath the foundation, ordered further work to cease. All the members agreed that the monument could not be completed according to the original design, because the foundation will not admit of more weight. The foundation was originally placed eight feet below the surface, and is now settled eight and three-fourth inches. The settling began while the monument was building, and as in settling the shaft leaned north, the builders still built according to the plumb-line, and the whole pile is crooked. The Board directed Gen'l. Q. A. Gilmore to prepare a report. He will suggest that the present weight of the shaft is all that the ground will bear. The report will be made to the commission appointed by Congress, of which the President is chairman, some time this week. This confirms the opinion of Supervising Architect Mullett.

RAILROAD NOTES.

The Car Accountants meet at Indianapolis, April 18th.

Work has been begun by Abbott & Co., on the Eastern Extension Road of Nova Scotia.

Capital stock to the amount of $50,000 has been subscribed in Racine, Wis., to build a street railway.

It is proposed to build a railroad from West Lebanon, Ind., westward to the C., D. & V. R. R. at Alvin, Ill.

Surveys of the Burlington, Keosauqua & Western R. R. Iowa, are to be made at once.

The grading of the road bed of the Philadelphia and Atlantic City R. R. is activley progressing.

The following new companies have been incorporated: St. Louis Fort Scott & Northwestern R. R. Co., place of business, Fort Scott, Kansas. Florence, El Dorado & Walnut Valley R. R. Co.; place of busines, El Dorado, Butler county.

The American Railway Master Mechanics' Association meets at St. Louis, May 15th.

The Master Car Builders' Association meets in Cleveland, June 13.

The Joliet Construction Company is negotiating with the Keokuk, North and South R. R. Company to build it to Mount Pleasant and Iowa City. A meeting of the two companies was held recently, which will doubtless result in placing the line under contract.

The name of the St. Louis, Rock Island and Chicago R. R. has been changed to the "St. Louis Division of the Chicago, Burlington and Quincy R. R."

Walker, Clark & Roberts of New York, the contractors of the Nova Scotia, Nictaux, and Atlantic Central R. R. will begin work May 1st. The road is 65 miles long.

Judgment has been given in the Saginaw Court, Michigan, against the Chicago, Saginaw & Canada R. R. Co., in favor of Thos. M. Nelson of Chicago, contractor, for $5518.18, and Thos. M. Nelson & Co. contractors for $18,057.50.

The railway from Vera Cruz to the city of Mexico is nearly 268 miles long, has many fine iron bridges and 18 lengthy tunnels. It cost the round sum of 40,000,000 of Mexican dollars, and is held to be the finest constructed railway on the American continent. Its greatest elevation above the sea at Vera Cruz is 13,000 feet.

A. A. Robinson, chief engineer of the A., T. & S. F. road, with a full corps of surveyors, commences work at once. The road will be fully completed to El Dorado on or before the middle of July. Col. Thomas Nickerson, who is now in Florida, has given instructions to Superintendent Morse to put this road through to El Dorado as soon as possible.

It is proposed to extend the Kansas Central (narrow gauge) R. R., from a point near Winchester, Jefferson county, via Oskaloosa, Topeka, and Council Grove, to Great Bend, Barton county. Meantime the direct line will be pushed westward from Holton through the northwestern portion of the State, with Denver as its ultimate destination.

A company has been formed for the entensive building of narrow guage roads. Mass meetings have been called in Ottawa, Saline, McPherson, Harvey, Sedwick, Butler, Greenwood, Woodson, Allen and Bourbon counties, to be held commencing March 15th, and ending April 3rd. The intention is to agitate the question, and induce aid by bonds under the amended law passed at the last session of the legislature.

The sum total of railway lines through the principal countries of the world now reach the distance nearly fourteen times the circumference of the globe, or one and one-half times the journey to the moon. Of this total the United States lines extend 75,585 miles; Great Britain at home and through her foreign domains, 66,101; Russia, in Europe and Asia, 34,914; those of France, 30,779; and of the German Empire, 18,799.

ARCHES;

CONSIDERED GRAPHICALLY.

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(*Continued from page 66.*)

41. Let us consider the two cases of a horizontal beam and of one inclined to the horizon at an angle i; it is known, from the usual formula for deflection, that, other things being equal, the deflection of a beam is directly proportional to the load and the cube of the length. If then the inclined beam is of a length l, and the horizontal one of a length $l \cos i$, as shown in Fig. 8, the deflections of each, measured perpendicularly to the respective beams, will, as regards length of beam only, be in the ratio of l^3 to $l^3 \cos^3 i$. But, if each carries the same load W, the transverse component of W, which alone causes flexure of the inclined beam, the longitudinal component producing direct compression, will be W cos i; whence the deflections perpendicular to each beam will, for similar points, be proportioned as 1 to $\cos^3 i$. And again, the vertical component of the deflection of the inclined beam will be to the perpendicular amount as cos i to 1; whence the *vertical* deflection of the inclined beam will be to that of the horizontal beam of the same

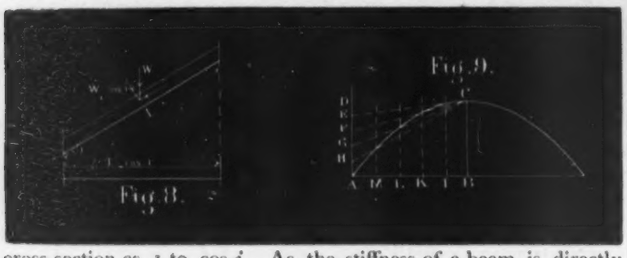


Fig. 8. Fig. 9.

cross-section as 1 to cos i. As the stiffness of a beam is directly proportioned to its breadth, should the inclined beam be made broader in its horizontal dimension than the horizontal beam, in the ratio of 1 to cos i, the depth being unchanged, the *vertical* deflections of the two beams for the same load would be exactly the same.

42. Any very small portion of an arch, taken within such narrow limits as to be considered straight, behaves like the inclined beam as regards its flexure under a load, and therefore it follows that, if an arch has the dimension perpendicular to its face increased, from the crown to the springing, in the ratio of the secant of the inclination to the horizon, it may be discussed as if it were a beam of uniform cross-section, of the same span, similarly supported, and carrying the same load which produces flexure. In the arch some of the load does not produce flexure, as in the parabolic rib, before cited, a uniform horizontal load gives equilibrium. We propose, in our analysis of the parabolic rib, to make this supposition, that the rib is broader at the abutments than at the crown in the ratio just mentioned, and thus to simplify the work of investigation. Iron arches whose flanges or chords are thicker as we approach the springing, in the above ratio, while the perpendicular depth between the two flanges is constant, practically satisfy this case. In this class of ribs the intensity of the direct thrust on the square inch will be the same at all cross-sections.

43. As we desire the reader to reproduce, on a much larger scale, the figures and problems for himself, it will be best to give an easy method of constructing a parabola for an arch, or for a curve of equilibrium for a complete load, uniform per foot of span. If A B, Fig. 9, is the half span, and B C the rise of the desired parabola, whose vertex will be at C, draw A D, perpendicular to A B, and equal to B C. Divide A B into any convenient number of equal parts, and divide A D into the same number. Draw straight lines from C to the several points of division of A D. The point where C E cuts the vertical from I, the one where C F cuts the vertical from K, C G that from L, and so on, will be points in the desired parabola.

44. Taking up then the case of the parabolic rib, hinged at the ends only, let us place a single weight at the point I, Fig. 10. If the lines A C B fulfil the condition of §11, that the sum of the products of the ordinates D E and E F for all points of the arch equals zero, or

$$\Sigma\, E F . D E = 0, \qquad (4.)$$

A C B will be the required curve of equilibrium. From the reasoning of §42, it will be proper to divide the areas above the springing line A B by equidistant vertical lines, moderately near together, scale off the quantities corresponding to E F and D E, and find the proper position of A C B by one or two trials. It can be thus located with all desirable accuracy, as a slight movement of the point C vertically alters the quantities to be computed very materially. The reader who is not familiar with the higher mathematics can thus verify the results we are about to obtain.

45. Since C G may be considered the unknown quantity, by which to locate A C and B C, the one condition of equation (4.) will readily give it, and its exact value can be determined by the integral calculus.

Let the half span A K = K B = c; the height or rise of the arch at the crown = k; then if K G, the distance from mid-span to

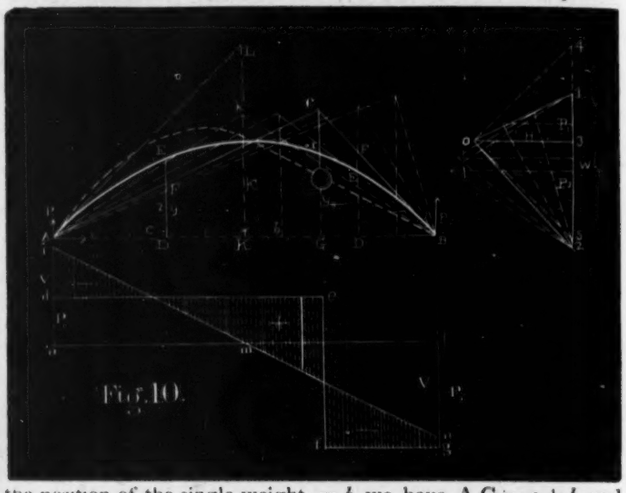


Fig. 10.

the position of the single weight, = b, we have A G = $c + b$, and G B = $c - b$. Let the required maximum ordinate C G = y_0. Let A D, the distance from the abutment A to any ordinate D E, between A and G, = x. Since the ordinates to a parabola from the line A B are proportional to the product of the segments into which they divide the span, we have

$$D E : k = x(2c - x) : c^2, \text{ or } D E = \frac{k}{c^2}(2cx - x^2).$$

$$\text{Also, } D F : y_0 = x : c + b, \text{ or } D F = \frac{y_0}{c+b}\, x.$$

The required condition is that

$$\Sigma\, E F . D E = 0, \text{ or } \Sigma (D E - D F)\, D E = 0;$$

therefore,

$$\Sigma\, D E^2 = \Sigma\, D F . D E. \qquad (9.)$$

Substituting the values of these lines from above, and writing the sign of integration, we get for the left hand member,

$$\int_0^{2c} \frac{k^2}{c^4}(2cx - x^2)^2\, dx = \frac{k^2}{c^4}\int_0^{2c}(4c^2x^2 - 4cx^3 + x^4)\, dx.$$

$$= \frac{k^2}{c^4}\left(\tfrac{4}{3}c^2x^3 - cx^4 + \tfrac{1}{5}x^5\right)_0^{2c} = \tfrac{16}{15}k^2c. \qquad (10.)$$

For the right hand member, between A and G, we get

$$\int_0^{c+b} \frac{y_0}{c+b}\, x . \frac{k}{c^2}(2cx - x^2)\, dx = \frac{k\,y_0}{c^2(c+b)}\int_0^{c+b}(2cx^2 - x^3)\, dx$$

$$= \frac{k\,y_0}{c^2(c+b)}\left(\tfrac{2}{3}cx^3 - \tfrac{1}{4}x^4\right)_0^{c+b} = \frac{k\,y_0}{c^2}\left[\tfrac{2}{3}c(c+b)^2 - \tfrac{1}{4}(c+b)^3\right]. \quad (a.)$$

For the portion between G and B, if we write $c - b$ for $c + b$, and reckon x from B to the left, D F will equal $\frac{y_0}{c-b}\, x$, while D E will be unchanged; so that the integration for the right hand member of (9.), between G and B, and between the limits $x = 0$ and $= c-b$, will give

$$\frac{k\,y_0}{c^2}\left[\tfrac{2}{3}c(c-b)^2 - \tfrac{1}{4}(c-b)^3\right]. \qquad (b.)$$

These two portions, (*a.*) and (*b.*), for the right hand member of (9.) being added together, will produce, when the terms with the odd powers of b are cancelled,

$$\frac{k\,y_0}{c^2}\left(\tfrac{5}{6}c^3 - \tfrac{1}{6}cb^2\right).$$

Finally equate this value with (10.) to satisfy (9.) and

$$\frac{k\,y_0}{6c}(5c^2 - b^2) = \tfrac{16}{15}k^2c; \qquad \text{or}$$

$$y_0 = \tfrac{32}{5}k\,\frac{c^2}{5c^2 - b^2}, \qquad (11.)$$

which is the desired value of C G in terms of the constant quantities and the variable distance K G. This expression is plainly applicable to points on either side of K.

If $b = nc$, where n = a fraction of the half span,

$$y_0 = \frac{32}{5(5 - n^2)}\, k, \qquad (11'.)$$

a quantity independent of the span of the arch.

(*To be continued.*)

LOSS OF THE STAFFORDVILLE DAM.

Having arrived at the season of the year when the rapid melting of the snow combines with the spring rains to smell the watercourses, we expect to hear of rivers overflowing their banks, mills stopped by backwater, and more or less damage and inconvenience caused by freshests. But we did not look for the recurrence of a type of disaster which we have twice within a short time had occasion to regret. The breaking away of the dam at Staffordville, Conn., on the 27th of March, was the occasion, by the flood of water let loose, swelled by mill ponds in the Willimantic River below, whose dams also gave way, of the destruction of property in mills bridges, dams, houses, merchandise, railroads, etc., to the amonnt of some $300,000. Fortunately the loss of life was very small, owing to sufficient warning, and perhaps from this circumstance, or because the public is becoming used to such tales, the accident has excited but passing notice in the papers.

We have not been able to harmonize the several accounts to our entire satifaction, but can give some facts which will probably be of interest. The dam was on the east branch of the Willimantic River and was the property of a Reservoir Company, composed of owners of mills on the stream below. The reservoir was about a mile and one-quarter long and averaged a quarter of a mile wide; the dam, standing in a gorge of the stream bed, was about twenty-feet high at the deepest point of the valley, previous to this last fall, when it was raised six feet, and in length the main portion was perhaps 150 feet, a short dam. The front of the main dam was composed of masonry, four feet thick at the top and ten feet at the bottom in the middle, the front of the well being laid of rough stone in cement and the back of the same dry, while the middle of the wall was composed of broken stone and boulders without cement. The wall was backed by gravel and earth, and it is stated that when the additions were made last fall, this material was put in in a frozen state, so that it was not consolidated. At each end of the dam proper, which was built on a curve, was a wing of earth thirty feet thick at the base and fifteen feet thick at the top, which was built in the early winter, the earth being banked up in freezing weather. The wings seem to have been the weakest portions. It is also stated that a large cast iron waste pipe four feet in diameter was introduced for the purpose of carrying off the surplus water. The water in the reservoir had never before been allowed to rise to the full height of the dam since it was raised, but the recent storm brought in so large a body of water that the level could not be kept down. A leak showed itself on Monday; workmen endeavored all that day and the following night to stop it. It seems to have occurred at the waste pipe, and finally, on Tuesday morning, gained so rapidly upon the bank that the waste pipe was shot out of its place and the breach was fairly made. The west wing of earth was thus rapidly eaten away, letting out the flood of water which carried off several dams in succession below. About 100 feet of the stone dam and the other wing of gravel is still standing at the east and north side of the break. Is is apparent, therefore, that the main portion of the dam, while perhaps rather poorly constructed, resisted the pressure, the failure occurring at the west wing, and a small portion of the main door being washed out as the flood hurried past the unprotected end.

We are inclined to attribute the breaking away to the percolation of the water, under the increased head, along the waste pipe, through earth not properly consolidated. The location of conduits and pipes through the body of embankments has been the cause of the failure of a number of dams otherwise sound. It will be remembered that such was practically the cause of the giving way of the Lynde Brook Reservoir last year,—lack of protection to the culvert or arch for the pipes. It is acknowledged by all to be a sound principle never to carry a pipe through an embankment, especially if new, if it can be avoided, and if one must, to hinder, by all possible means, the water from following along the side of the pipe. Any body which offers a continuous line for the guidance of a thread of water is dangerous, and the slightest settlement, which cannot be avoided with new filled earth, will open a crack along the pipe for the percolation of water, in the place most difficult of access. Wide flanges at intervals, jogs or counterforts of masonry, etc., are some of the precautions to be introduced.

It is possible, however, that the earth bank which composed the wing that was carried away failed independently of the portion adjoining the waste pipe. It is stated to have been very poorly and hastily put together, of earth more or less frozen, and therefore to have been ill adapted to withstand any head. It is highly probable that the owners expected to prevent the wings from being tested as they were, by keeping the water down.

It is very natural that such an accident, within a year from that near Worcester, should arouse the general press to cast a fling at engineers. But no one of our profession seems to have been called in to advise about, plan, or superintend this construction, and therefore we are not to be held responsible for the penny-wise economy of those men who add to and patch up a dam as they think best. Whether these repeated lessons will do any good to people at large is a question. The general public will not be likely to be any more cautious in the future, when they indulge in ignorant experimenting in this branch of engineering, than were this company of Staffordville mill-owners who, with the Lynde Brook disaster fresh in their minds, put a contractor to work late in the fall, to raise their dam and increase its head. We can, however, reap a certain advantage by the study of these cases of failure, and it is possible that some of the projectors of new works of this nature may be led to think, that true economy will dictate the employment of the best means in their power to make a dam safe, and that the advice and co-operation of an engineer who has made such subjects his special care will be well worth to them whatever they may cost.

THE Mill River disaster of May 16, 1874, when $1,000,000 worth of property was destroyed and 140 lives were lost by the sudden emptying of 114 acres of water into a narrow valley, and the accident at Lynde Brook, near Worcester, Mass., March 30, 1876, where a water-works reservoir gave way, as described in the NEWS at the time, causing damage to property of nearly an equal amount, but drowning only one person, recur naturally to our readers on hearing of this failure of a dam. In both of the above cases the structures were faulty in original construction.

WE have to announce that the proposed book on the Ashtabula Bridge accident edited by J. M. Goodwin, C. E. of Cleveland, O. will not be published at present, as the support accorded to Mr. Goodwin in the way of subscriptions was not sufficient to warrant him in incurring the great cost of publishing the book as he proposed. We regret this the more as there is no doubt that the book if published, would embody the greatest amount of valuable information on the subject of iron bridge building that would be extant in this country. We had the satisfaction of personally inspecting the manuscript and also the drawings, and we then thought that the subscribers would be very fortunate in securing such a work for the price asked, which, after the very lowest prices for labor and material were obtained both in Cleveland and Chicago, was barely sufficient to cover the cost of the proposed edition, without allowing the editor anything for his services. Mr. Goodwin is entitled to the thanks of the profession for the labor and money which he has expended in his attempt to present the official record of this noted accident to his fellow engineers, and we regret that his enterprise was not more widely appreciated.

PLATE No. IX of Sanitary Engineering was the last one issued; there will be about eight more and we will publish them as speedily as we can conveniently and *economically*. We publish this week a copy of specifications for a sewer in New York City, which we think will serve as a model for similar documents where they are needed.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 74th regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on Tuesday April 3rd, President Chesbrough in the Chair.

After approval of the minutes of the preceding meeting the Secretary reported the following donations to the library:

From Gen. A. A. Humphreys, Chief of Engineers U. S. Army—"Report of a Reconaissance, from Carroll, Montana, to the Yellowstone National Park and return; by Wm. Ludlow, Captain of Engineers.

From Chas. Paine, General Superintendent of Lake Shore and Michigan Southern Railroad—Report of miles run by passenger equipment wheels for three years.

Pamphlet—The M. S. & N. I. R. R. Co. *vs.* Samuel H. Turrill—Brief for Appellant.

From United States Lighthouse Board — Memoir upon the Illumination and Beaconage of the Coasts of France.

Wm. Sooy Smith, C. E. read a paper upon "New methods of making iron and steel, with a letter from Mr. A. T. Hay, of Burlington, Iowa, supplementing it with remarks and replies to questions put by many of the members present. By request Gen. Smith then read a description of the process of rust or oxidation in iron, and the new method of protecting it by aid of superheated steam.

The Secretary gave the particulars and details of the proposed trip to New Orleans at the invitation of the American Society of Engineers. The Illinois Central Railroad Company will furnish free transportation available to and from New Orleans to members of the Club.

The report and discussion upon the Metric System was postponed, and the meeting adjourned.

THE RANSOM STEAM STREET CAR.

As the subject of the application of steam to the propulsion of street cars is attracting considerable notice, and as we have referred, in our issue of March 10, to the Ransom Steam Street Car which has been introduced upon the Market street railway, of Philadelphia to a limited extent, we have extracted from the correspondence of the *Railway Review* a description of this car and engine, as built by the well-known manufacturers, Gilbert, Bush & Co., of Troy, N. Y.:

"Mr. Ransom has given many years study to the subject, and has finally attained success. Some two years ago Gilbert, Bush & Co. being convinced that Mr. Ransom's theory was a correct one, agreed to build an experimental car, which was tested on the different roads of Troy with success. It was afterwards exhibited in various parts of the country. It is called the "Pioneer" car, and has run 12,000 miles. None of the working parts show the least indication of wear. This car is now in the shops being refitted for running on the West Troy & Albany street railroad. A company has been organized, styled the Ransom Steam Street Car Co., with E. G. Gilbert, President. The company have in the shops four cars nearly completed, part of an order of six for Philadelphia, two of which have been shipped. The cars are models of beauty, resembling the drawing-room car. From the outside they appear longer than the ordinary street car. The inside of the car is richly finished; various kinds of woods are used, mahogany, walnut, rosewood and silver maple panelings. Heavy cushions are used, and cushioned seat backs. The car is lighted by an exceedingly brilliant silver-plated reflecting center lamp. The roof is similar to the modern steam car, or what is called the raised roof, running from end to end, with ventilator over the doors. The car is warmed by steam-pipes running the whole length. The boiler is upright, and encased in a wooden jacket It is made of the best charcoal hammered iron, and will resist a pressure of 500 pounds to the inch, while the pressure need not exceed 120 pounds. The escaping steam is passed through a two-way valve out of the smoke-stack and a muffler without making the slighest noise. The action of the wheels is the only noise heard when the car is in motion. The car cannot by any chance escape from the control of the engineer, as the brakes can be operated either by steam or hand. The lever moved a certain distance comes in contact with an automatic arrangement which, at the will of the engineer, tightens or releases the brakes. The engine is 20-horse power, and is hidden from sight in a dust-tight box made under the car floor, and independent of the car, being supported by the drive-wheels and an arm suspended from a cross beam. The whole is accessible by means of trap doors. The distributing valves are in the cylinder heads, giving a steam port of ⅞ inch. The cylinders are 5¼ inches in diameter and 14 inch stroke. When the engine is in full gear the steam will follow the piston 10 inches and exhaust at 12½ inches. The pump is under the car body at the rear end (inclosed), and can be got at from the outside by lifting lids. The tank is under the rear end of the car, and by means of a hole through the car above the wheels, hose may be introduced into the tank at any street hydrant and a supply of water obtained. The tank will hold 130 gallons of water, enough to run it 15 miles. There are two sand boxes under the seat, capacity half bushel each. One oiling a day is sufficient, as all the working parts have oil cellars. The total cost of running this car is $7 per day, and it is capable of doing the work of four horse cars. A street broom and scraper are attached to the car truck, which clears the track of snow or mud. The cars are about evenly balanced, and ride as easy as any horse car when empty and easier than the horse car when loaded."

ENGINEERS AS RAILWAY SUPERINTENDENTS.*

BY JOHN B. JERVIS, C. E.

Now, it may be said, why all this about the superintendency of a railway—engineers are not much engaged except in construction? My object is to show that an engineering education fits a man best for the superintendence, no less than for the construction of a railway. I regard it an error that the profession has not given more attention to superintendence of operations. It demands the same thoughtful analyzing mind, to operate, that constructs. I have presented this case to impress the importance of employing the best engineering experience and ability in the superintendence of railways. The case is a plain one. Say, management has failed to pay interest, and the railway was sold by foreclosure of mortgages. An engineer takes charge, and in 2¼ years this is all changed and the property becomes a success. But why an engineer? A true engineer first of all, considers his duties as a trust, and directs his whole energies to discharge the trust, with all the solemnity of a judge on the bench. He is so immersed in his profession that he has no occasion to seek other sources of amusements, and is therefore always at his post. He has no ambition to be rich, and therefore eschews all commissions that blind the eyes and impair fidelity to his trust. His ambition is to make his trust a success to the proprietors. His education fits him to analyze facts, and more successfully than a layman to produce the best results of administration. To reach the best results of railways, they must be put under the superintendence of competent engineers.

It may be inquired, why should not engineers seek to be rich? certainly, they need the benefit of pecuniary resources as well as others, which is not denied. *Rich* is a relative term. The man who, by proper economy, is able annually to lay something by as as an investment from his earnings, is only exercising the prudence necessary to provide for age or infirmity. This all men should do, and it is especially important for an engineer, and by this means his mind may be at ease in regard to the future. What is meant by a thirst to be rich, is a speculating turn of mind, which is sure to prevent any especial eminence in an engineer. He should be careful to secure a proper salary, and then give his undivided attention to the duty he assumes. I have known several engineers who were always on the alert for speculation, but I have not known one such to secure any valuable standing as an engineer. To this it may be said, engineers have not, in all cases succeeded in conducting the operating business of railways. The same may be said of lawyers, or any other profession, and it is just as important that the party in interest select a competent and faithful engineer as a competent lawyer. The same discretion is necessary in one case as in the other.

Being now past four score years of age, I can have no other motive than the public good in the above remarks. I make them in view of much personal experience, which has brought me to the conclusion, that the railway and kindred public works will not realize their legitimate benefits until their supervision is committed to competent engineers. In order for this, it is necessary to cultivate the profession so as to secure the qualifications and character before named, to carefully avoid all theories that are not based on well established and thoroughly analyzed facts, and to be very cautious before applying any theory, to see that all the facts involved are obtained, and that none are hastily and inconsiderately assumed. The profession is one of great importance to the public interest, and no pains should be spared to fully qualify those who pursue it for every engineering emergency, and to fit them for the discharge of every duty with scrupulous fidelity.

The table below shows the prices paid for water in the following German cities using water meters:†

City.	*Price per cu. meter. (1000 liters)*	*Price per 100 gallons.*
Altona	5 3-10 cents.	2.00 cents.
Berlin	1⅞ to 7½ cts.	0.71 to 2.84 "
Braunschweig	1¼ to 2 cts.	0.48 to 0.75 "
Bochum	1 3-5 to 2½ cts.	0.63 to 0.95 "
Cassel	1⅝ to 2¼ cts.	0.61 to 0.95 "
Carlsruhe	1⅞ cts.	0.71 "
Cologne	1¼ to 2½ cts.	0.48 to 0.95 "
Danzig	2 1-10 cts.	0.75 "
Dortmund	2 1-10 to 2½ cts.	0.75 to 0.65 "
Dresden	3 cts.	1.14 "
Dusseldorf	1⅝ to 2 cts.	0.61 to 0.76 "
Eisenach	3¾ to 6¼ cts.	1.42 to 2.37 "
Essen	1 7-10 to 2 1-10 cts.	0.63 to 0.75 "
Frankfort	1 7-10 to 2½ cts.	0.64 to 0.95 "
Freibourg	1¾ cts	0.66 "
Halle	1 7-10 to 2 7-10 cts.	0.63 to 1.02 "
Kiel	2½ cts.	0.95 "
Leipzig	2¼ to 2¾ cts.	0.85 to 1.04 "
Magdeburg	1⅝ to 2 cts.	0.61 to 0.80 "
Posen	2⅞ to 3¼ cts.	1.09 to 1.28 "
Stuttgart	3¾ to 5 cts.	1.42 to 1.93 "
Wiesbaden	2½ to 6¼ cts.	0.95 to 2.37 "
Witten	1¼ to 2½ cts.	0.48 to 0.80 "
Vienna	2 4-5 to 5¾ cts.	1.06 to 2.00 "

Average, 2.748 cts. per cu. m., 1.041 cts. per 100 galls.

* From a Memoir of American Engineering published in Transactions of American Society of Civil Engineers, Feb. 1877.

† *Wochenschrift des Oster Eichischen Ingenieur und Architekten-Vereines, Wien.*

ON THE PROBABLE ERRORS OF LEVELING; WITH RULES FOR THE TREATMENT OF ACCUMULATED ERRORS.*

BY WILFRED AIRY, B. A., M. INST. C. E.

TABLE II.—AVERAGE DIFFERENCES in a SINGLE MILE DUE to GROUND of VARIABLE INCLINATION—COMPUTED from the RESULTS of TABLE A. by the FORMULA.

Prob. Diff. = $\sqrt{}$Mean of squares of diffs. due to the several slopes of ground.

Character of the ground.	Average Difference in a single Mile. Great Britain.	India.	Switzerland.
	foot.	foot.	foot.
(1) "Level ground," in very favorable circumstances of weather. Example.—A broad level valley or margin of a lake	.0230	.0142	.0125
(2) "Gently undulating ground," where the gradients rarely, if at all, exceed 1 in 100. Example.—Most of the roads in India	.0238.	.0168	.0148
(3) "Steeply undulating ground," where the gradients rarely, if at all, exceed one in 20. Example.—Most of the roads in Great Britain	.0316	.0189	.0166
(4) "Mountain roads," where the gradients rarely, if at all, exceed 1 in 10 Example.—The mountain roads in Switzerland	.0416	.0254	.0224
(5) "Very steep and rough ground," where the gradients frequently exceed 1 in 10, and the leveling is carried over mere road tracks or paths	....	....	.0416

NOTE.—Quantities in black partly estimated as per Table I.

Having thus determined the 'average differences' from the results of standard leveling in different countries, it remains to form a table of the probable errors due to those differences. The proper method of doing this will be found in the "Theory of Errors of Observation," art. 60; and from the formulæ of that article it can be shown that if there be two independent measures of the same quantity the probable error of each measure is 0.477 × difference of the measures, and the probable error of the mean of the two measures is 0.337 × difference of the measures. With these coefficients it is easy to frame a table of probable errors applicable to the cases of lines which have been leveled once or twice.

C. THE TREATMENT OF PROBABLE ERRORS IN THE CASE OF A COMPLEX SYSTEM OF LEVELED LINES.

This is illustrated by working out in detail an example showing the application of the theory of probable errors in adjusting the levels of a number of points connected by lines of leveling on the 'polygon' system, the closing error of the chief polygon being 0.286 foot.

* From the Proceedings of the Institution of Civil Engineers, London.

Let A B C D E F G A be the polygon system (Fig 2), of which all the lines have been separately leveled.*

TABLE III.—PROBABLE ERRORS of the RESULTS of SINGLE or DUPLICATE LEVELING on GROUND of DIFFERENT CHARACTERS, FORMED from the RESULTS of the SWISS LEVELING.

Character of the Ground. (For Definitions, see Table II.)	Average Difference in a single Mile of Two Observers (see Table B)	Probable Error in a single Mile of each Observer. Multiplier = .477.	Probable Error in a single Mile of the Mean of Two Observers. Multiplier = .337
	Foot.	Foot.	Foot.
Level ground	.0125	.0596	.0421
Gently undulating ground	.0148	.0706	.0499
Steeply undulating ground	.0166	.0792	.0559
Mountain roads	.0224	.1068	.0755
Very steep and rough ground	.0416	.1984	.1403

The lines B C, C D, C F, and F G have been leveled twice each, and the remaining lines once. The length in miles, and the character of the ground, are written against each line.

The first thing to be done is to form a table of the probable errors of the several lines from Table III. If a line has been leveled once only, the probable error in a single mile, is to be taken from the third column of Table III; but if twice, it is to be taken from the fourth column of the table, and applied to the mean of the observed results.

With these probable errors the equations of the determination of the levels of the points A, B, C, D, etc., can be formed, in the most probable manner, in accordance with the method of 'least squares.' The final results, together with the effect of the corrections, are shown in Table V. The heights are measured from datum-level 500 feet below the point A.

Thus the effect of the corrections is to raise the points B and C a little, and to lower E, F, G, and A′ considerably. This seems consistent with the nature of the ground, which from A to D is favorable, and the corrections are small. From D through E and F to G the distance is long and the ground rather steep, and it is accordingly on these lengths that the corrections are heavy. At the same time the cross lines B G and C F, though short, are steep, and would well allow of the

* The polygon system of the example, with the lengths of the lines and the observed levels of the several points, is taken from an actual case in the "Nivellement de la Suisse." The description of the ground is not given in the "Nivellement," and is to some extent hypothetical.

Fig. 2.

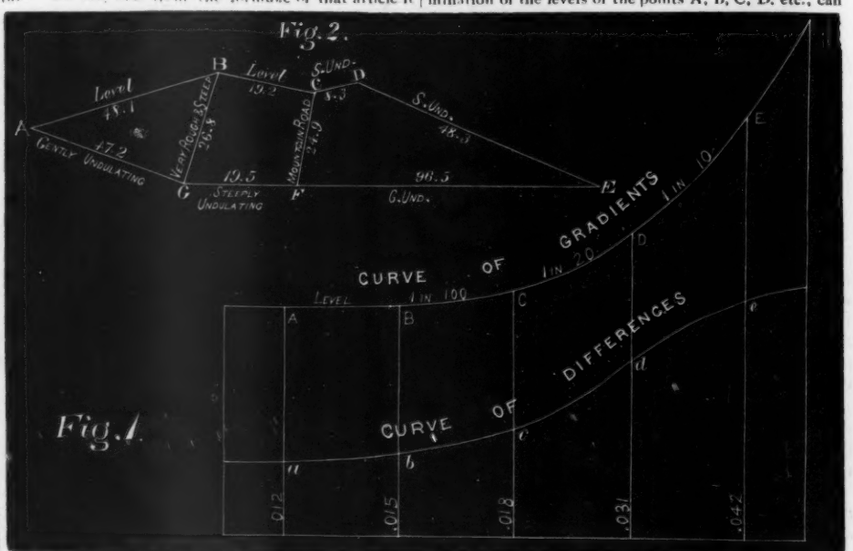


Fig. 1.

heavy corrections required by the corrected levels of G and F. The final correction to A is of course the closing error of the polygon, as shown by the observed levels.

TABLE IV.
PROBABLE ERRORS of the LINES A B, B C, C D, ETC.

Section.	Observed Difference of Level of the two ends of the Section.	Character of the Ground.	Number of times Leveled.	Length of Section.	Probable Error in a Single Mile, from Table C.	Probable Error of the Section = Probable Error in a Single Mile × √Length in Miles.
	Closing Error = .286					
A B	Feet. 193.458	Level	Once	Miles. 45.1	Foot. .00596	Foot. .041
B C	15.860[1]	Level	Twice ...	19.2	.00421	.018
C D	699.887	Steeply Undulating...	Twice ...	8.3	.00559	.016
D E	—1322.470	Steeply Undulating...	Once	48.3	.00792	.055
E F	955.880	Gently Undulating...	Once	96.5	.00706	.069
F G	155.125[1]	Steeply Undulating...	Twice ...	19.5	.00559	.025
G A	—607.454	Gently Undulating ...	Once	47.2	.00706	.048
B G	503.961	Very rough and steep.	Once	26.8	.01984	.103
C F	332.935[1]	Mountain road	Twice ...	24.9	.00755	.038

[1] Mean results.

TABLE V.—FINAL RESULTS and EFFECT of the CORRECTIONS.

	Height above Datum.		Difference.
	As obtained by leveling round from A through B,C,D,&c.,to A.	As corrected by Theory.	
	Feet.	Feet.	Foot.
Level of point A.	500.000	500.000	.000
do do B.	693.458	693.464	+ .006
do do C.	709.318	709.325	+ .007
do do D.	1,409.205	1,409.202	— .003
do do E.	86.618	86.618	— .117
do do F.	1,042.015	1,042.319	— .296
do do G.	1,197.740	1,197.445	— .295
do do A.	500.286	500.000	— .286

D. REMARKS ON THE INSTRUMENTS AND METHODS OF WORKING USED IN ACCURATE LEVELING.

For the Standard leveling in Great Britain, India, and Switzerland, Y levels were used. This construction offers facilities for the quick and accurate determination of the collimation error and the level error. Its chief disadvantage is that, from want of rigidity in the mounting, it sometimes happens that the internal tube (which carries the object glass) does not slide truly in the external tube, so that the optical axis does not keep constant in position when focussing the telescope. This defect is remedied in part by Mr. Gravatt's construction, which, however, introduces inconvenience in respect of the collimation adjustment. In the instruments used for the Swiss leveling the spirit-level is movable, and is clipped upon the telescope tube—a construction which has no apparent advantage. In the English and in the Indian instruments the spirit-level is always attached to the telescope. In some levels recently constructed for foreign governments by Messrs. Troughton and Simms, the spirit-level is attached to the frame which carries the telescope, instead of to the telescope itself; by this arrangement the level is more firmly secured and less liable to accident.

Table VI contains the essential information relating to the instruments and staves used in the initial leveling of different countries.

In the Swiss leveling the distances were always measured by taking the reading on the staff of two fixed wires in the diaphragm of the telescope, and corrections were afterwards applied with much labor in respect of all the instrumental errors due to the difference of distances. In Great Britain and India the distances were always chained equal.

In India Colonel Walker discovered that the instruments had a tendency to settle on their axis between the reading of the back and forward staves. This would tend to produce a cumulative error, and he has therefore established a rule of alternating the order of observation at successive stations of the instrument, by reading the back staff first at one station and the forward staff first at the next. The special necessity for this appears to be mainly due to the practice of unshipping the instruments at every station for removal to the next station. To counteract the cumulative error originally noticed by Dr. Whewell, which is introduced by leveling a line continuously in the same direction, all the lines of the initial leveling in Great Britain were leveled both ways from end to end. In India the same end is gained by splitting up the long lines into short sections of 4 or 5 miles in length, and leveling alternate sections in opposite directions. But no precautions appear to have been taken in the Swiss and French leveling to guard against these accumulated errors.

Errors may easily be caused by an inaccurate method of placing benchmarks. Thus it has been usual in England to cut benchmarks deeply on the vertical faces of walls, and from the inconvenience of ascertaining the exact level of the center of the mark, it is easy to make at once an error as large as would be generated in a considerable length of leveling. In the Swiss leveling the benchmarks were always defined by bronze bolts let into a horizontal face.

[*To be continued.*]

PUBLICATIONS RECEIVED.

Twenty-fifth Annual Report of the Board of Water Commissioners of the city of Detroit. Detroit, 1877.

Transactions of the American Society of Civil Engineers, for March. New York. 1877.

Annual Reports submitted to the Board of Councilmen of the city of Newport, Ky., for the year 1876.

Zeitschrift des Architekten-und Ingenieur-Vereins of Hanover, for January, 1877.

First Annual Report of the Trustees of the Sandusky Water Works, from date of organization to Dec. 31, 1876. Sandusky, O., 1877.

Annual Report of the Executive Board in charge of the Departments of Water Works, Fire, Highway and Street Improvements of the city of Rochester, N. Y., for the year 1876.

Geographical Surveys in the United States, Remarks upon Professor J. D. Whitney's Article in the North American Review, July, 1875, Concluding with an Account of the Origination of the Pacific Railroad, by Gouverneur K. Warren. Washington, 1877.

From the Institution of Civil Engineers, London:

The Repairs and Renewals of Locomotives by Alexander McDonnell, M. Inst. C. E.

On the Combustion of Refuse Vegetable Substances, such as Straw, Reeds, Cotton Stalks, Brushwood, Megass, etc., under Steam Boilers, By John Head, Assoc. Inst. C. E.

DEFECTIVE SEWERAGE.

The subject of defective sewerage is now agitating the public mind and awakening a degree of serious and thoughtful interest that indicates the full realization, at last, that the evil is one fraught with immediate danger to the health and life of our citizens. The peril is one that threatens all alike and in meeting and treating which the entire community can have but a common interest. And, as a matter of course, the very first measure of safety, the first step toward the practical remedy of existing defects as well as the sure prevention of like defects in sewers to be laid hereafter, is to get at the cause of the trouble already experienced. And here are some facts bearing upon the subject which ought to aid in the solution of this problem of public safety. In the first place, there are now and always have been men in this city calling themselves sewer-builders, and having licenses for doing sewer work, who are totally unfit for the business, and as long as such men are granted licenses our citizens must endure the consequences of defective sewerage. Another point is that there is now for sale in the city an enormous quantity of what is termed cull or No. 2 pipe, which, in order to secure trade even among those with whom its defective character is a matter of notoriety, is sold at very low figure. This cheap pipe is not only of a very poor quality in respect to soundness, but is made from a coarse fire-clay which will not vitrify, and, although it may be hard burned, it still remains as porous as a sponge, utterly incapable of standing the acids and gases of sewers any more than a common drain tile,—notwithstanding all which, unless careful scrutiny is exercised by those in authority, this miserable pipe will still be laid in spite of all practical vigilance on the part of inspectors. And here is still another very important point which has not yet been presented to the public, and that is the growing tendency to use socket pipe in the place of ring pipe, which has always been used without exception, until within the last two or three years. There are serious objections to the use of socket for the reason that it is extremely difficult to form a close connected joint on the under side of the pipe and in case (as so frequently happens) it is not well cemented and made permantly tight the liquid matter from the sewer soon works through, emitting its unwholesome stench and leaving in the sewer the heavy deposit of matter which soon obstructs the circulation and leads to the necessity of cleaning out. It is a pertinent fact, too, that there is nowadays twice the amount of sewer cleaning over that required at an earlier day, when only ring pipe was in use. As yet there has not been a foot of socket pipe laid in the main sewers of the city, and if ring pipes are best adapted for main sewers, it is reasonable to infer that they are best for private sewers, and the time has come when the welfare and the safety of the community requires that this matter of defective construction and improper material in sewer-building should be seriously and thoughtfully dealt with.—*Chicago Times.*

WATER SUPPLY OF EUROPEAN CITIES.

While Glasgow has tapped Loch Katrine and Manchester and Liverpool have gone to the Cumberland or Welsh lakes for water, London is compelled to pump and strain Thames water and choke while drinking it. This Spring the water is more unwholesome than ever, owing to the disastrous floods of the Winter. It is yellow and turbid, thick with the washings of the acres that have been overflowed, discolored by the chalk of the Berkshire and Oxfordshire hills, and filled with fungoid growths and moving organisms. Under these circumstances the Metropolitan Board of Public Works has taken steps to improve the water supply, and by buying out the existing companies to put the water works under municipal management. Rate-payers will not listen to the proposition to resort to other sources of supply, such as the head waters of the Severn, and London will have to drink contaminated water for many years to come. The filter beds used by the companies can be cleaned and repaired, and new wells can be sunk in the chalk northeast of the city, but these half-way measures are not likely to afford permanent relief. Not only is the water unwholesome; there is not enough of it.—*N. Y. Tribune.*

NOTES.

Three bridges were swept away between Amherst and Northampton, Mass., by the freshet.

Work on the proposed new postoffice at Pittsburgh, Pa., will shortly begin.

The new Court Theatre is being built in Vienna at a cost of $2,500,000.

The bridge over the river at Saco, Me. has been closed to travel, being pronounced unsafe.

Reports from Conway, N. H., state there is an immense volume of water there.

The pipe lines in the oil region, Pa., have consolidated and are managed by one board of directors.

The Cincinnati Southern R. R. bridge over the Kentucky river is said to be the highest in the world.

The Waterworks Commissioners, of Toronto, Ont., purpose erecting a new reservoir at a cost of $175,000.

GEN. O. S. BABCOCK has been assigned to the charge of the Fifth Light House District, with headquarters at Baltimore, Md., relieving Major Franklin Harwood.

Alderman Joseph Brunet, contractor and trader, of Montreal, has made an assignment for the benefit of his creditors. His liabilities are about $150,000.

The water is now being put in the West Branch canal, Pa., from Lock Haven down. The Williamsport level and mill ponds are filling, and navigation will be open early.

The Saco river is rising rapidly. The saw mills are all shut down. The river above Saco is a solid mass of ice, which, if it should start now, would cause much damage.

The stonecutters in the employ of Mr. Davis, contractor for a portion of the Lachine Canal Works, Montreal, Canada, struck for an advance of wages, their demands having been refused.

The Harbor Commissioners, of Quebec, are applying to the Dominion Government for an additional sum of $250,000, which is required to ensure the carrying out of the harbor improvements. Mr. Varret has been elected Secretary of the Commission.

Reports from Maine indicate that the rivers are very high. Some damage has been done and more is anticipated. Seventy feet of Moulton's stone dam on the Big Togus River, near Gardiner, were swept away this afternoon, causing a loss of about $2,000.

The Susquehannah river at Pittston, Pa., owing to the eighth inch fall of snow which succeeded the heavy rains

lately, has swollen to an alarming extent. Continually rafts of logs and timber have been floating past, and should the river continue to rise it will no doubt do some damage to property in the Wyoming Valley.

The Connecticut river at Bellow Falls, Vt., has risen considerable lately, the heavy and continuous rains having had the effect to swell all the streams and rivers. Large quantities of floating ice, logs, lumber and stumps have passed rapidly down stream. The river is still rising and fears are entertained of a disastrous freshet in the Connecticut valley.

The engineers appointed by the Niagara Suspension Bridge Company to examine and report upon the state and stability of the bridge have completed their duty, and reported to the effect that the bridge is entirely safe for the transit of regular trains such as have hitherto-fore used it. The commission consists of W. Milnor Roberts, chief engineer of the Northern Pacific Railroad; T. E. Sykels, chief engineer of the Union Pacific Railroad, and W. H. Payne assistant engineer of the New York and Brooklyn Bridge. It is understood that a further report from these gentlemen is promised in a few days, giving tests, with drawings, and the reasons in detail for the opinion expressed.

About as startling a proposition as has yet been devised by modern engineering is the scheme gravely advocated by the Liverpool *Post* to block up the Straits of Belle Isle. The object is to divert the passage of the ice which now comes down every year from Baffins Bay, through the Straits, and makes the shores past which the icebergs float many degrees colder than those to the eastward that face the ocean and get the benefit of the Gulf Stream. It is believed that, if the project could be carried out, the entire climate of Anticosta and of the Gulf of St. Lawrence would be largely modified, and navigation through the neighboring waters could be kept open during the whole year. In the narrowest portion the width of the Straits is eight ond one-half miles.

A contract was awarded to Messrs, McLees & Co., of Twelfth and West streets, New York, for manufacturing 140 tons of galvenized anchor bars, for the last series of bars, for the bridge. The cost is to be one cent per pound.

LOCOMOTIVE ENGINEERS.

An important step has just been taken by the directors of the Philadelphia & Reading Railroad Company. It is a declaration of open war against the Brotherhood of Locomotive Engineers, the protective organization of the trade. The directors have issued an order to all the employees of the road denouncing the Brotherhood and announcing that the engineers in the employ of the company will in a few days be called upon to decide "under which king" they will serve, threatening discharge to all who refuse to leave the Brotherhood. What the ultimate effect of this order will be cannot be foreseen, for the Brotherhood will not be likely to yield without a struggle.

The order is as follows:—

"PHILADELPHIA & READING RAILROAD COMPANY,
OFFICE NO. 227 SOUTH FOURTH STREET,
PHILADELPHIA, *March 27, 1877.*

Mr. ———, Locomotive Engineer:—

DEAR SIR.—In view of the recent high handed interference with the business of railroad companies, and the serious and sometimes fatal consequences that have resulted to the innocent traveling public from the unjustifiable and arbitrary conduct of the organization known as the Brotherhood of Locomotive engineers upon other railroads, it has been deemed unadvisable to retain in the employment of this company any one who is a member of that organization.

If you are in such membership you will be called upon in a day or two to decide whether you desire to remain in the employment of the company by complying with the regulation requiring you to withdraw from the association referred to.

It is not the desire of the company to deprive its employees of any of the beneficial or life insurance features of the Society of the Brotherhood of Locomotive Engineers without offering in their stead greater benefits of a similar character; and it is therefore proposed by the company to establish and endow a life and accident insurance fund, out of which all engineers, upon payment of a monthly sum less than previously paid, will receive, in case of accident or death, greater benefits than those heretofore derived from the Brotherhood of Locomotive Engineers.

Upon being informed of your desire to continue in the employment of the company the undersigned will be pleased to give any information you may desire as to the details of the beneficial fund, and to discuss with you directly any question involving your relations with the company.

Respectfully yours.

J. E. WOOTEN, *General Manager.*"

Upon the recommendation of Engineer C. C. Martin a contract was entered into with the Brady Manufacturing Company, of Plymouth street, Brooklyn, N. Y., for making 120,000 couplings for the bridge cables. The material is to be furnished the contractor, who is to manufacture the coupling required at the cost of four cents a piece.

NEW METHODS OF MAKING IRON AND STEEL—A LETTER FROM MR. A. T. HAY—WITH AN INTRODUCTION BY WM. SOOY SMITH, C. E.*

Without assuming to endorse a process for making iron which is just beginning to challenge our attention, I desire to present it for the consideration of the members of the Club; believing that a careful study of a whole family of metallurgical processes which seem to grow out of one fruitful invention cannot prove unprofitable to us.

Much of the popular ignorance respecting iron and steel results no doubt from the error of regarding iron as iron and steel as steel, instead of the alloys which they really are, differing widely in chemical constitution and physical properties.

The quality of any particular sample of iron or steel depends, first, upon its chemical composition, and, secondly, upon its mechanical structure. Starting with identity of chemical composition, it is practicable to secure uniformity in mechanical structure. But so strong are the affinities of iron for the various substances which enter the ores, fluxes and fuel employed in its manufacture, and so variable are these affinities under the necessary thermal conditions, that heretofore it has been exceedingly difficult to so control them as to secure uniformity in the product. This fact has been painfully evident to the civil engineers of the country who have been charged with the construction of bridges, roofs, machinery, etc., upon the strength and durability of which large numbers of human lives depend.

A few of the iron makers of the country have, by long and faithful effort and under the most favorable circumstances as to the materials available, succeeded in making brands of iron which command general confidence. But up to the present time it has been exceedingly dangerous to rely upon the irons and steels sold in open market. Perhaps undue attention has been devoted to a single series of iron compounds, namely, that resulting from its union with carbon in various proportions.

More recently iron and steel have been studied with reference to the compounds of iron with other substances, such as manganese, silicon, chromium, aluminum, nickel, etc., and with the most important and promising results. One investigator, Mr. A. T. Hay, now asserts that by using a sponge which he is able to produce by means of a magnetic furnace, he can so perfectly control the action of the affinity of iron for other substances as to cause it to unite with those which he supplies to it in this sponge and thus produce a class of most valuable iron compounds with absolute certainty.

He claims to have thoroughly investigated the electrical relations that subsist between iron and the other substances isomorphous with it at the various temperatures required in the production of those compounds, and that by attention to these relations he secures the compounds desired. His processes are now in course of thorough practical demonstration, and an iron is produced by them at the Wyandotte mills which is said to equal if it does not excel the best Swedish iron in softness and toughness. Tons of this material are now on sale in this city, similar to the specimens which we have the pleasure of examining here this evening. And be it remembered this is but one of a large class of products which the inventor claims to be able to make by his process. Indeed there is scarcely any of the ordinary desirable characteristics of iron which he will not undertake to impart and at a trifling increase of cost.

A method which promises so much in the production of excellent iron and steel for our use cannot fail to interest the genuine civil engineer, and the attention of the Club is therefore invited to the following letter describing it, which was written by Mr. Hay, by request.

General Wm. Sooy Smith, Chairman U. S. Commission for testing Iron and Steel, Chicago, Ills.

DEAR SIR: In response to your request, I will state: Iron is not found to any extent in native masses, but in ores mineralized by different elementary metals and substances in a state of oxides, carbonates, etc., and with many of these elementary metals, it is isomorphous, and when revived to a metallic state, they alloy or combine with it in variable proportions. It is upon these alloys or combinations that depends its real value. Iron chemically pure, is neither desirable nor practical, it being too soft for mechanical purposes, besides it has a great affinity for oxygen, at ordinary temperatures, and rapidly corrodes and wastes away. The isomorphous group to which iron belongs consists of fourteen elementary metals, six of which are electro negative to iron and seven are electro positive to it, at ordinary temperatures. Two of these are pyro electric and change polarization toward iron under thermic conditions at a cherry-red heat, and three give their electricity to iron above 90° Fahrenheit, and take it away from it below that temperature. That is, iron alloyed with its regular electro positive elements will be fibrous or granular and strong, and not seriously affected by cold; and an alloy with pyro electric elements will render the product "red short," but tough and fibrous when cold. And any combination containing electro negative elements, to an extent that the iron becomes the most positive element in the alloy, will render it "cold short," crystalline, and brittle with a powerful affinity for phosphorus, sulphur, etc. Such iron will be tough when hot, but become weaker and more brittle as the temperature falls below 90° Fahrenheit. There is a well known chemical law that governs the effect of the sulphur, phosphorus, etc., upon iron products. Two bases are never taken to form a double salt from the same isomorphous family group; hence, if iron becomes the electro-positive element in any given alloy, the metalloids will combine with it alone, and the product will be bad, while on the other hand if the iron is rendered the electro-negative metal in any given alloy, then the poisonous metalloids will combine with the more positive elements, and the product will become malleable, ductile and tenacious. In a word, it will be fine iron. Swedes iron, so celebrated throughout the world for its fine qualities and steel properties, is assimilated in its ores *only* with the isomorphous elementary metals of the *electro-positive* series. Out of hundreds of assays of Swedish ores examined not one contained any of the isomorphous elements of the *electric-negative* series, (save and except copper and cobalt, and these were very rare). See Sweden's iron report for 1876. Besides iron and carbon, fine carbon steel also invariably contains two or more of these electro-positive elements, including traces of phosphorus and sulphur.

Under thermic conditions it will be found that some of the electro-negative elements assume the positive and give their electricity to iron, while other negatives become electro-positive to iron and protect it from acidulous influences, practically revealing the fact that the best alloy for iron will depend entirely upon what it is wanted for. The most valuable alloy to resist compression, stress and strain at ordinary temperatures is not the best adapted under the thermic conditions, nor will either of these be suitable under acidulous influences. Therefore, without having regard to the chemical, electrical, pyro-electrical and thermic relations that exist between iron and the members of its own family, including the effects and affinities of the metalloids upon the various combinations, it is utterly impossible to give what we call iron any definite quality; and observing these relations it is practical to make iron and steel of any given character and quality absolute and certain. Hence any tests of iron and steel founded upon ordinary merchant bar in stock, will be comparatively of but little value so long as we remain in ignorance as to what they contain, and are unable to reproduce metals identical in constitution to those tested. Rest assured of one thing, certain, and that is the economy, durability and safety of all iron structures depend upon these isomorphous combinations. These principles and facts are all made manifest and practical under the Hay metallurgic processes, which relate to the manufacture and use of a ferruginous alkaline sponge, that may contain severally or combined, beginning with iron and aluminium, any other one or all of the regular isomorphous metals of the electro-positive series, including one or more of the alkalis proper, and for certain qualities of iron requiring a high resistance to heat and acidulous corrosion. Metals from the electro-negative series may be incorporated in the sponge, which is prepared from the oxides, clorides, fluorides, etc., as found in nature, by means of a magnetic furnace having from four to six electrical zones, whereby those refractory oxides, etc., are easily reduced in combination with silica to a silicious-metalic mat or sponge, which is fusible at a bright red heat; and when introduced into the puddle or forge fires the metals therein chemically combine in stock. It is also a deoxidi ing and a desulpurizing agent and a perfect welding flux that renders high steel as weldable as iron at a glowing white heat, with a decided improvement in quality of product over the original stock. Thousands of tons of cast steel have been faggoted and rolled into wire rod at the Harrison wire works, St. Louis, of which Thomas W. Fitch (late of the United States navy) is president, and William L. Reynolds superintendent. It also renders practical, a stratified (iron and steel) boiler plate, adding tensile strength, and in such a combination, under thermic conditions, the steel becomes the electro-positive metal, and protects the iron against corrosion. The sponge has already become a saleable product, and at this time commands one hundred dollars per ton, and five per cent. thereof is sufficient to make "fine iron" out of Iron mountain, of Missouri, Lake Superior, Tennessee and other good pig irons. The process is not a single process involving but a personal or individual interest, but a metallurgic family of processes, with a broad principle underlying them as essential to successful iron manufacture as the principles of agricultural chemistry are to successful farming. No genuine advance in the manufacture of iron and steel is possible (except by accident), if their constitution and the means of imparting it are lost sight of.

These processes underlid all true iron metallergy, and therefore deserve early, thorough and exhaustive examination and investigation on the part of all practical investigators. Respectfully submitted to your consideration. I am, sir, very respectfully yours,

A. T. HAY.

BURLINGTON, IOWA, February 19, 1877.

* Paper read before the Civil Engineers' Club of the Northwest, April 2, 1877.

THE MULTIPLICATION OF INDUSTRIES.

One cause which has been assigned for the stagnation of industries felt during the past few years has been over-production. All manufactured articles were put upon the market in greater quantities than the demand called for, and consequently the time soon came when prices were lowered. We can make more iron, more paper, cotton, cloth, shoes, sewing machines, mowing machines, railway cars, etc., than we can use. The stimulus of the excessive call for certain classes of articles at the time of the war is thought to be answerable for the result. However this may be, the fact remains that we have experienced a long stoppage of the wheels of industry, although now an encouraging revival and a call for manufactured products seems to have already begun. The market which has been opened to our wares abroad we have alluded to before, and, in addition to the articles then spoken of, we notice that shipments of American glassware have been made to England, which are said to compare favorably with the best English glass, in color, finish and the power of resisting changes of temperature.

But it was not in this direction that our thoughts were turning to-day. If some branches of industry are crowded, and the capacity for production is beyond the present consumption, it behooves us to enlarge the scope of our labor by taking up and fostering other branches which have been much neglected. There are doubtless many manufacturing operations which can be carried on to advantage in places where the raw material, coal or power, labor and the means of living are cheap, which have heretofore been left to other countries. Employment would thus be given to many hands at present idle, and a field would be opened for the use of capital which now is unimproved. The lines of investment in railroad bonds and kindred securities are closed by reason of public distrust, arising from a remembrance of past experience, and therefore legitimate and properly secured projects in manufacturing, initiated and prosecuted with due discretion, ought to be able to command such capital as may be needed.

Our success in new directions in recent years should be an encouragement to other undertakings, and those manufacturers who can turn their attention and their machinery to operations which are nearly allied to the old ones, so that the machinery can be easily adapted and the former experience be serviceable in the new pursuit, will be most likely to find the change profitable, and be able to give work to waiting laborers. Thus mills which produced cottons have been turning their attention to finer grades and to cotton and wool goods; woolen manufacturers are producing alpacas and dress goods. It needs only a brief mention to recall our successes in several directions. We formerly purchased all our watches abroad; now we turn out a native product which, by the aid of most exact and ingenious machinery, averages better than the imported article, and we are encroaching on the foreign market; American silks have made a place for themselves within a few years, and our sewing silk rivals that of Italy in quality and cheapness. There appears to be no reason why we should not make our own linens, growing our own flax, of which we imported last year $17,000,000 worth. We can make our own pottery and ornament it. Our art schools and classes in industrial design will make us independent of foreign decorators. We can rival Sheffield in cutlery, if we please. The *Journal of Commerce*, of St. Louis, says, "We are still importing $7,000,000 of iron and steel, some $10,000,000 of leather and goods; $22,000,000 of silk goods; $4,000,000 of soda and salts; $10,000,000 of tin plates; $35,000,000 in woolen goods, amounting" with flax, hemp cotton goods, china and glass ware, "to nearly $250,000,000 annually paid out by our people to foreign nations for their labor, and this, not because we are better employed in making something to a better advantage to exchange for it, but because we are a new nation and have not yet developed these industries in our midst."

The *American Manufacturer* has been urging the expediency of making the tinplate in this country which we now import in large quantities, and a recent writer sets forth the cost of the materials and labor required, with an assurance that a handsome profit can be realized. He states that "the adaptation of American iron for tin plate in tenacity, and surface, cannot be surpassed, and, when intelligence and economy are practiced in its manufacture, it will be more remunerative than any other branch of the iron industry."

The editor of *Scribner's Magazine*, writing upon this topic urges its importance very strongly "Out into these fields the capitalist must reach or find no profitable employment for his money. Into these fields labor must go, or lie idle and descend into pauperism. It is not a matter of choice with us, it is a matter of necessity. Of course it will take a good many years to accomplish the results we seek. There must be costly experiments; there must be processes of education of head and hand; there must be time for capital to move itself; but the change must come, and towards these fields the public attention should be immediately directed. Our only hope for steady and permanent prosperity lies exactly here. We must produce for ourselves, and thus employ the nation's idle capital and idle hands, and the quicker the movement is made, and the more efficiently it is prosecuted, the earlier our old and much longed-for prosperity will come back to us. The subject is full of interest, and crowds the coming century with changes and developments which the most hospitable imagination must fail to measure."

While we still feel that a gradual revival of our industries has begun which will surely lead to prosperous times, we also feel that it behooves us to enter upon the cultivation of some of the new fields which lie open to individual or corporate enterprise.

We notice that iron sleepers are said to be on trial on a portion of the Central Pacific Railway, with satisfactory results. Their description, as given in the *Railway Age*, is as follows:—

"They consist of circular concave plates, sixteen inches in diameter, with a saddle upon the top in which the rail is set, much as in the ordinary chair. The outer half of the saddle is cast with a plate or bed-piece, and the inner half is secured with bolts after the rail is in place. An iron cross bar connects the plates on opposite sides, the bar having a joint in the center held by a bolt, with an elastic material in the joint. Elastic material is also placed between the rails and the bed-plates."

These sleepers appear to be much like ones used by English engineers in India with good results. The bowl is made large enough to give the desired bearing on the ballast, which, in the English sleepers, is, we believe, tamped through two holes at the sides and their form gives great strength. Where wooden sleepers are expensive, from scarcity of timber, they may compete with the more perishable material, but the experiment with iron sleepers in some parts of India was tried because ants were so destructive to wood. In the number of the NEWS for February 17, page 44, will be found the statement of Mr. Higinbotham in regard to their employment in India.

We have felt moved to make but one remark in regard to the method of discussing a bridge truss, as set forth by our correspondent on page 75, of the number of the NEWS for March 31, and that is rather of the nature of an inquiry. But in the first place we would say that, as he undoubtedly agrees with us in regard to the final or resultant forces on each portion of the truss, it is not so much matter how far he carries a stress round if he only brings it finally upon the right piece, and secondly, as at any section we must have equilibrium between the stresses in the pieces cut by the section and the external forces on one side of such section, the ordinary equations of statics will give the desired stresses in each panel without regard to their paths elsewhere. A graphical diagram drawn by Clerk Maxwell's method, will indicate by simple inspection how individual loads tend to change the stresses in the braces, and will show that the final stress is the algebraic sum of the partial stresses. And, finally, we know that our original answer was considered satisfactory by the engineer who propounded the query.

But to our remark:—As our correspondent has, in his second figure, brought 6000 lbs. of steady load upon the left abutment through the first brace; as he states that stresses cannot pass up compressive members, and that horizontal members cannot carry a vertical force, (by Proposition 6 and 4); and as he states that 7200 lbs. of live load, if now placed at the lower end of the first vertical, will all go to the left abutment,—how does he get the extra 1200 lbs. of dead load, as he thinks, off from the left abutment on its way to the right abutment where it is needed?

THE Water Works "Crib" was inspected on Wednesday the 11th inst., Captain Falcon, the diver, examining the portion below the surface of Lake Michigan, and notwithstanding the alarming predictions of a certain engineer, the structure was found to be as free from any indications of dissolution, or even from damage, as when it was erected. A detailed report of its condition will be given on this Saturday, and any points of general interest we will give to our readers next week.

WE are reminded by our reference to the Brooklyn Theatre fire of our thoughts as we were slowly making our exit from McCormick Hall on the occasion of the Ole Bull Concert a short time ago. We give it as our personal opinion that in case of a fire in McCormick Hall in this city, and its ensuing panic, that not one person in ten would escape, and we do not believe that even that proportion of those in the gallery would escape. We do not know how a worse exit could be arranged, except it be a genuine labyrinth.

No country in the world can compare with this in genuine "sensations," but at what a fearful sacrifice of life and property we are earning our most unenviable reputation. The burning of the Southern Hotel at St. Louis is the most recent in the long list of terrible calamities that incompetence, ignorance, recklessness or carelessness have inflicted upon the American public. A theatre represented to be "perfectly safe," with the most ample means of escape which architectural skill could devise, proves to be a fire trap from which there was really no escape; an iron bridge on the model road of the country turns out to be devoid of every principle of safety, and the horrible scenes at Ashtabula are the results, and now comes the story of the inmates of a great hotel awakening, not an hour after midnight, to find themselves surrounded by flames, and all escape from death cut off. In the name of humanity what was the interior construction of the Southern Hotel that in two hours it should be consumed; what kind of service also did its proprietors give to their guests that at that early hour of the night smoke and flames could roll through the corriders and halls to gain such headway that escape was impossible to the wretched tenants of the upper stories? What next, and whose turn will it be to pay the penalty of American greed for money?

A REGULAR meeting of the Chicago Chapter American Institute of Architects was held April 5, 1877, at the rooms of the Treasurer, 85 Dearborn St. The minutes of the last meeting were read and approved. The proposed amendment to Section 4, Article IV of the By-Laws was taken up and passed by a unanimous vote.

Mr. James R. Willett then read an illustrated paper entitled "Perspective by Scale."

Mr. Bauer made some interesting remarks on Architectural Education, which gave rise to discussion which was participated in by the members generally.

On motion, adjourned.

HENRY L. GAY, *Secretary.*

Written for "Engineering News."

REMARKS ON THE SLOPE OF SOUTH PASS, AND A PART OF THE LOWER MISSISSIPPI RIVER.

BY MAX E. SCHMIDT,

Ch. Asst. Eng. South Pass Jetty Works.

Ever since the commencement of the Jetties at the mouth of South Pass (June 18th, 1875) the engineers in connection with the works considered it highly important to possess some reliable information relative to the elevation of the water-surface of South Pass at any point of its length, and at different stages of the Mississippi River and the tides. Unfortunately, for want of time, this information could not be obtained previous to the construction of the works that are now erected at the head and at the mouth of the Pass. Many phenomena which occurred under the agency of these works, might otherwise have been explained, whereas without previous knowledge for over a year the field was open to conjectures and suppositions.

The distance between the head and the mouth of the Pass being about twelve miles, with banks chiefly extending over marshy grounds, leveling was looked upon

as an undertaking almost too delicate to be tried, except at extreme low river, when the soil would possess stability enough to support the leveling instrument. Moreover the rich growth of reeds, which skirt the Pass on both sides, being particularly impenetrable at the little ridge or natural levee, close to shore, which would be the path the leveler would select, the leveling itself was thought of only as a "*dernier resort*."

Having so many difficulties to contend with, and so little time to spare, another method had to be substituted, a brief description of which will be given below, and only recently, and aided by exceptionally low water, a line of levels was successfully run on the west bank of the Pass. The results of both observations are before us, developing many interesting data.

The first observations were made without a level at least without the instrument we call "level." Owing to the low stage of the Mississippi, the hydrostatic conditions of the Delta had reduced the slope of the river below New Orleans practically to a horizontal plane, on which the small tides of the winter season would fluctuate, causing a perceptible inland current, when the tide would come in, and slight flow out after the tide had turned. How very little resistance the current of the Mississippi River offered to the ingress of the tide was determined by simultaneous gauge-readings, made at the mouth, the head of South Pass, and at Quarantine Station, 37 miles above the mouth, where the same fluctuation to a tenth of an inch was recorded at precisely the same time.

Under these conditions then it was only necessary to consult the action of the tides a few days in advance, and choose the time of the Moon's least (0) declination, when the tides are known to be smallest and stationary, thereby to avoid the application of too great a correction, and mark the elevation of the water-surface at a given time on stakes previously driven along the Pass, while tide-gauges were being observed simultaneously at several important places.

At South Pass additional precautions were taken to insure correctness. The stakes were driven every mile commencing from South Pass Light House up and down stream; the circles on the diagram represent the location of the stakes. At the same time tide-gauges were placed at A, B, C, D, E, F, G, H, I and K, those in the Pass (A, C, E, G,) being connected by careful leveling with the corresponding ones in the bay (B, D, F and H). Above the head of the passes, at the jump, quarantine and New Orleans, gauge-readings were also noted.

The value of the observations to be made, depended now solely upon the weather, a calm clear day, and the greatest possible elimination of the tides being absolutely necessary for an even adjustment of the Gulf-level and the water in the bays to the east and west of South Pass. On a calm day, at low river, especially after a long series of calm days, and at a time when the moon's position keeps the tidal wave off this shore, it can be claimed that for all practical purposes the levels of the two Bays and those of the more remote portions of the Gulf are in equilibrium. Therefore, as long as the alluvial banks are tight enough to hold the volume flowing in the Pass, and as long as there is no knowledge of a percolation or any other hidden subterraneous drainage, there is no reason why not to accept the difference of readings of two gauges, A and B for instance, as the fall between point A and the Gulf of Mexico. The levels run afterwards proved this to be correct.

The smallness of the dimensions dealt with, when attempting to obtain a figure for the slope of South Pass, is the only one great difficulty in arriving at correct results by any other mode than leveling. What at the Upper river could justly be overlooked as being equal to a mere "fraction of an error" becomes of considerable importance here where the slope is reduced to as insignificant a figure as one or one-half inch per mile.

The observations were made with great care four times, January 9th, 19th, 20th and March 28th, of the present year. On the first date the weather was not favorable, but the results proved satisfactory on the others.

It was at first the intention to mark the water-surface at all the "mile points" simultaneously; but, as this would have necessitated quite a corps of assistants, the marking was done as fast as possible with a steam-launch starting from the head of the Pass down, and stopping at every "mile-point" just long enough to drive a nail, where the water-surface would indicate it at that moment. The tide-gauges being read in the meantime every ten minutes, at the points described above, enough data were obtained to construct the slope of the Pass for the precise time, when a nail was driven, and any correction that had to be applied, could with facility be taken off from the plat itself.

The zero, which appears on the profile of slopes, and to which all elevations are referred, is the plane of "Average Flood Tide," as determined by the U. S. Engineers for the works at the mouth of the Pass. Knowing the height of each nail above this plane, gauges could now be set with their zero at the same elevation, and the difference of readings on these gauges would indicate the fall in the Pass from one mile to another.

However, before definitely setting the gauges, it was decided to run a line of levels between one or two of the "mile-stakes," as a check on the elevation of the nails. Under considerable difficulties this line of levels was finally extended over the entire distance from the head of the Pass to Port Eads, and thence over the

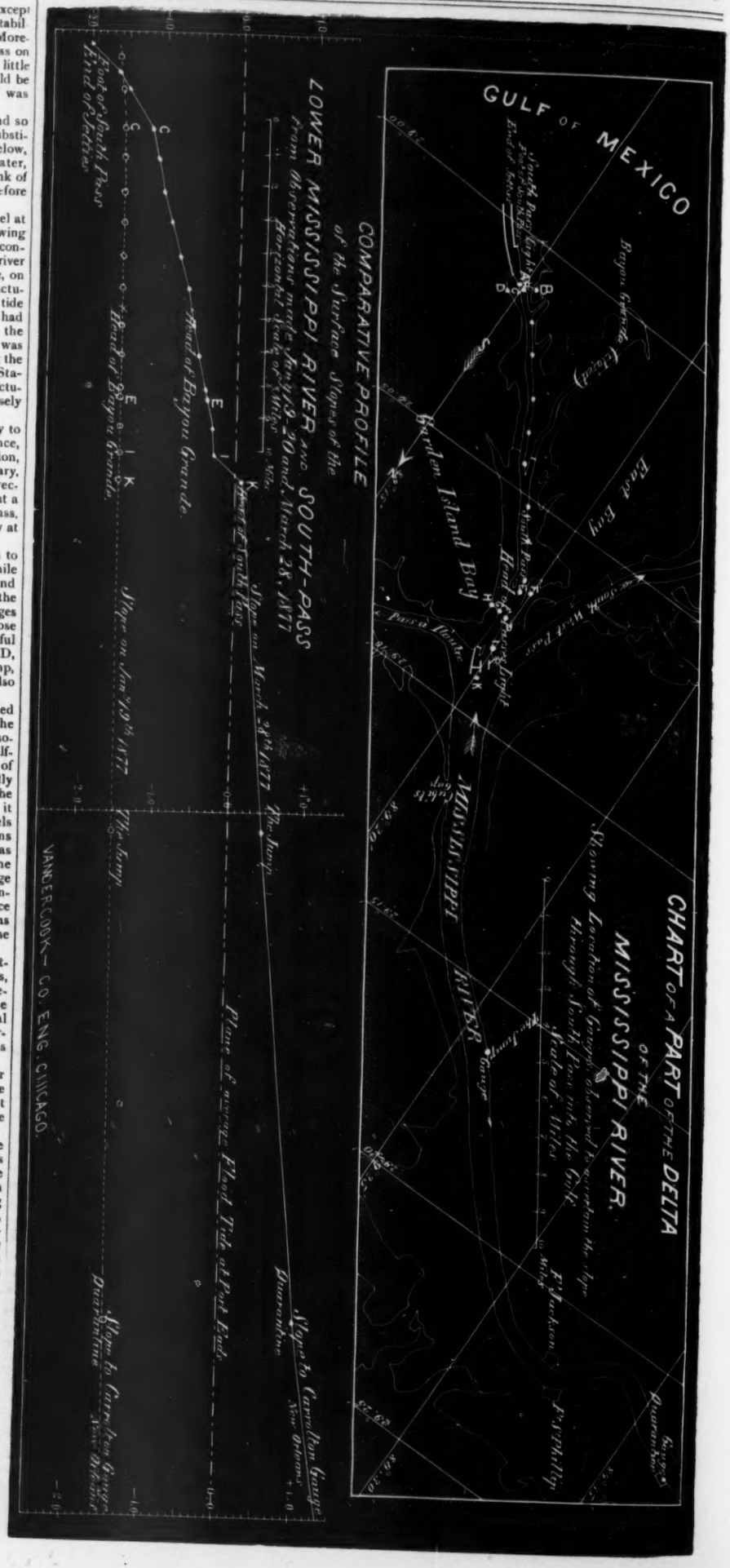


CHART OF A PART OF THE DELTA OF THE MISSISSIPPI RIVER.
Showing Location of Gauges observed to ascertain the Slope through South Pass into the Gulf.
Scale of Miles
GULF OF MEXICO
Bayou Grande
Garden Island Bay
Head of Bayou Grande
Head of South Pass
South West Pass
Pass a Loutre
MISSISSIPPI RIVER
Quarantine
Port Eads
COMPARATIVE PROFILE
of the Surface Slopes of the
LOWER MISSISSIPPI RIVER AND SOUTH-PASS
From Observations made January 19-20 and March 28, 1877
Horizontal Scale of Miles
Vertical Scale of Feet
Slope on March 28th 1877
Slope on Jan'y 9 & 19th 1877
The Jump
Plane of Average Flood Tide at Port Eads
Slope to Carrollton Gauge New Orleans
Slope to Quarantine
VANDERCOOK & CO. ENG. CHICAGO.

jetty lines to the present mouth of the Pass. The appended table gives the results of both observations in a computed form.

TABLE OF ELEVATION OF NAILS ABOVE AVERAGE FLOOD TIDE.

Location of Stake with reference to So. Pass Light House.	Elevat'n by Surface Observations		Mean.	Elevation by Locks.	Difference.
	Jan. 19.	Jan. 20.			
2 inches below.	0.724	0.654	0.689	Nail.	Gone.
1 " "	0.746	0.743	0.745	"	"
1 " above.	0.683	0.721	0.702	0.732	—0.030
2 " "	0.718	0.755	0.737	0.735	+0.002
3 " "	0.738	0.757	0.748	0.777	—0.032
4 " "	0.754	0.748	0.740	0.733	+0.007
5 " "	0.790	0.788	0.789	0.820	—0.031
6 " "	0.790	0.778	0.784	0.813	—0.029
7 " "	0.850	0.850	0.850	0.900	—0.050
8 " "	0.766	0.715	.736	0.796	—0.060
9 " "	0.715	0.715	.715	0.781	—0.066

The two comparative slopes in the diagram represent the descent of the Mississippi, *exclusive of tidal influence* from New Orleans through South Pass into the Gulf. The flat slope occurred on January 19th, when the Mississippi at New Orleans was 15½ feet below high water mark of 1874, and the steep slope on March 28th when the river at New Orleans was within 7.8 feet of that high water mark. Attention is called to the sudden declination in slope, caused by the increased volume being forced into the defiles, created by the works at the head and the mouth of South Pass. It is obvious, that while passing through these works, the regimen of the Pass is disturbed, but it is also evident that the steep sope indicates the certainty of a very substantial enlargement of section by scour, yet to be effected, before the equilibrium throughout the Pass will be regained. That the latter process is daily advancing you have already heard through Mr. Corthell's letter, published in one of your last issues.

In conclusion, the following table showing the rate of fall, as a guide to the diagram, may be of interest.

TABLE SHOWING RATE OF FALL PER MILE BETWEEN THE MAIN STATIONS FROM NEW ORLEANS TO THE MOUTH OF THE JETTIES, JAN. 19, AND MARCH 28, 1877.

From	To	Distance in miles.	Total Fall January 19.	Total Fall March 28.	Fall per mile January 19.	Fall per mile March 28.
			Feet.	Feet.	Feet.	Feet.
Carrollton Gauge	Quarantine	77.00	0.00	4.00	0.00	0.051
Quarantine	Gauge K	37.00	0.00	1.90	0.00	0.034
Gauge K	South Pass Light	10.070	0.05	0.40	0.00	0.025
South Pass Light	End of Jetties	2.369	0.00	0.89	0.00	0.088
			0.14	0.81	0.059	0.346

AMERICAN SOCIETY OF CIVIL ENGINEERS.

The Ninth Annual Convention of the Society will be held in New Orleans, Tuesday, Wednesday and Thursday, April 24th, 25th and 26th next.

Sessions for the consideration of professional subjects, and one for the transaction of regular business, will be held at the Chamber of Commerce (on Common Street), beginning at 9½ o'clock A. M. Tuesday, and continued on Wednesday.

It is proposed, on Thursday, to visit objects of interest in and about New Orleans, and to have the Convention dinner at 7½ o'clock that evening; on Friday and Saturday, to inspect the jetties at the mouth of the Mississippi, stopping on the return at the orange groves and at some of the sugar plantations; and on Monday to go to the Bonet Carre Crevasse.

A trip to Galveston (by steamer leaving New Orleans, Wednesday, May 2d), to visit that city and the United States works there, is also proposed.

In accordance with the rules governing Conventions, a list of topics to be considered at the regular sessions is submitted, with references to the Papers treating these subjects, published in Transactions since May, 1876.

I. BRIDGES.

CXXXVII. The Failure of the Ashtabula Bridge. C. Macdonald. March.

CXL. Approximate Determination of Stresses in the Eye Bar Head. W. H. Burr. April.

II. HYDRAULICS.

CXXV. On the Failure of the Worcester Dam, a Report. T. G. Ellis, Chairman. July.

CXXVI. Cut-offs on the Mississippi River, their Effect on the Channel, above and below. C. G. Forshey. September.

CXXX. Efficiency of Steam Vacuum Pumps. J. F. Flagg. December.

CXXXI. Principles of Tidal Harbor Improvements, as applied at Wilmington, Cal. C. B. Sears. December.

CXXXVI. A Water Conduit under Pressure. J. T. Fanning. March.

CXXXIX. Consumption and Waste of Water delivered by Public Works. J. H. Harlow. April.

Report of Committee on Gauging of Streams. J. J. R. Croes, Chairman. To be called for.

III. MASONRY.

CXXXIII. Reconstruction and Enlargement of the Cork Run Tunnel, on the Pittsburgh, Cincinnati & St. Louis Railway. M. J. Becker, January.

CXXXIII. Notes on Masonry of the East River Bridge. F. Collingwood. January.

Report of Committee on the Nomenclature and Classification of Masonry. J. J. R. Croes, Chairman. June, and to be called for.

IV. RAILROADS.

CXXXVIII. On the Form, Weight, Manufacture and Life of Rails, a Report. A. Welch, Chairman. October.

CXXIX. A Cheap Transfer Table. W. P. Shinn. December.

CXXIV. On Railroad Accounts and Returns. W. P. Shinn. June.

Report of Committee on Uniform Accounts and Returns of Railroad Companies. W. P. Shinn, Chairman. November, and to be called for.

Report of Committee on Resistances of Railway Trains. W. P. Shinn, Chairman. To be called for.

V. STRENGTH OF MATERIALS.

CXXVII. Qualities of Iron and Steel. W. Metcalf. October.

CXXXIV. The Rate of Set in Metals Subjected to Strain for considerable Periods of Time. R. H. Thurston. January.

Report of Committee on Tests of American Iron and Steel. W. S. Smith, Chairman. November, and to be called for.

VI. MISCELLANEOUS.

CXXXV. A Memoir of American Engineering. J. B. Jervis. February.

CXXXVIII. Co-Ordinate Surveying. H. F. Waling. March.

Report of Committee on Metric System of Weights and Measures. C. Herschel, Chairman. To be called for.

The following are set down for

THE BUSINESS SESSION:

Report of the Centennial Commission of the Society. T. G. Ellis, Chairman. To be called for.

Report of Committee on Quarters for the Society. J Bogart, Chairman. To be called for,

The topics will be taken up for discussion in order, and members are invited to take part in person, or by sending what they would say; it is hoped that those having memoranda of experience or data relating to any of the subjects named, will present it. Papers on other professional topics are solicited, and if announced in time, their titles will be included in the Schedule to be in April Proceedings. Notice of intention to present a Paper or to take part in the discussion, should be given to the Secretary *at once.*

The Boston Society of Civil Engineers, of Boston; the Civil Engineers' Club of the Northwest, of Chicago; and the Engineers' Club of St. Louis, have been invited to attend the Convention, and to take part in the proceedings.

It is proposed that Eastern members proceed together from New York, join the Western members at Louisville, and go from there, either by rail to Memphis and steamboat down the Mississippi, or by rail direct to New Orleans The time (in hours) required will be about as follows:

New York to Louisville, rail	31
Louisville to Memphis, "	16
Memphis to New Orleans, river	36
	—83
New York to New Orleans, all rail	65

As soon as arrangements are completed, a time-table and schedule will be issued.

Head quarters of the Society in New Orleans will be at the St. Charles Hotel.

Papers on Engineering Subjects, giving results of practice, or in discussion of pertinent theoretical questions, are desired from members of the Society; their comments (whether or not present at meetings of the Society), upon papers published in Transactions, are solicited, and they are urged to contribute from notebooks and other similar records, whatever may bear upon the subjects considered, or refer to other practical topics. A list of subjects relating to the practice of engineering and its connection with kindred art and public afairs, on which papers are desired, may be found on page 51, Vol. I.

The following are the current elections, changes and corrections of members, etc.:

Additions.—Eckley B. Coxe, Drifton, Pa., February 7, 1877; William C. Gunnell, Eng. of New Capitol, Hartford, Conn., Feb. 7; Sandford Horton, 176 Franklin st., New York, Feb. 7; David E. McComb, As't Eng. on Work west of Capitol, Washington, D. C., Feb. 7.

Changes and Corrections.—Charles E. Billin, 4039 Locust st., Philadelphia, Pa.; James D. Burr, Sup't Bridge and Buildings, A. T. & S. F. R. R., Topeka, Kansas; Theodore Cooper, Office of Ch. Eng. Erie R'y, New York; Edwin A. Doane, Box 317, Meadville, Pa.; Samuel M. Gray, City Eng., 17 North Main st., Providence, R. I.; John W. Hill, Box 729, Hamilton, O.; Gabriel Jordan, Ch. Eng. & Gen. Sup't M. & C. R. R., Memphis, Tenn.; Erasmus D. Leavitt, Jr., 143 Magazine st., Cambridgeport, Mass.; William H. McClintock As't Eng. Water Works, 175 Third av., Louisville, Ky.; Cook Talcott, San Francisco, Cal.; Henry Tyson, Box 707, Baltimore, Md.; Howard W. White, 13 Revere st., Boston, Mass.; Oscar F. Whitford, Joplin, Mo.

Resigned.—John H. Sargent, Cleveland, O., February 28, 1877.

THE POINT BRIDGE.

From the Pittsburgh *Leader* of April 1st, we take the following account of the Testing of the Point Bridge:

"We are at last enabled to announce the completion of the Point Bridge across the mouth of the Monongahela connecting the lower part of Pittsburg with the South Side and Temperanceville. An informal opening took place yesterday morning, the occasion being the passage over the bridge of Mr. Jacob Painter, one of our oldest citizens and one of the largest stockholders in the bridge, accompanied by Mr. Jas. I. Bennett and a number of personal friends in carriage, among whom we noticed Mr. J. N. Mc Cullough, B. F. Jones, John Chalfant, Campbell Herron, Mark Watson, H. W. Oliver, David Stewart, Alex. Byers, Alex. Nimick and Max Moorhead.

The American Bridge company availed themselves of opportunity yesterday, through the kindness of the mill-owners of the South Side of making a test of the carrying capacity of the bridge.

After Mr. Painter and company had passed the bridge in carriages the heavily loaded teams being stationed along Carson street on the South Side, drew up a file upon the bridge. The approaches not being paved yet, and consisting of new fill, made it difficult to pull the heavy loads upon the bridge. The teams were arranged two abreast upon the bridge, a case which will never occur under regular traffic, but this was done to test the resistance of the structure to its utmost. The following statement gives the number of teams, their weight, and the total weight being at the same time upon the bridge:

	Tons.
2 six-horse teams	27
12 four-horse teams	120
1 three-horse team	8
5 two-horse teams	30
1 one-horse team	2½
2 buggies	3
25 four-mule teams	225
Weight of people on the sidewalks	60
Total weight upon the middle span	474½

This weight is equal to 12 locomotives, or to a crowd of over 7,000 people.

Altogether there were on the main span at same time 48 teams with 176 horses or mules and about 900 people.

With all this load on, the bridge deflected 4 inches in the center of the span, which is only ½ of an inch for every 100 feet of span, whereas the deflection allowed in railroad bridges is almost 1 inch for every 100 feet.

Niagara bridge, being of near the same length, deflected, when new, 10 inches under the load, and this deflection was increased in course of time to 14 inches.

The most interesting part of the test was the observation of the undulations and oscillations of the bridge under the moving load. For this purpose two level instruments and one transit were used, the levels being placed upon the piers at each end of the main span and the transit upon the south-side embankment.

The oscillations could scarcely be noticed; the up and downward movement during the passage of the load were not over one-sixteenth of an inch; the lateral motion in the center of the bridge five-sixteenths of an inch.

When one-half the span was loaded and the other half unloaded, the loaded side deflected 2¾ inches and the unloaded side was raised 1⅛ inches, which is simply due to the elasticity of the material, and proved the stiffening system of the bridge a complete success.

The designer of the bridge, Mr. Hemberle, stated that his expectations in respect to rigidity in the bridge were quite surpassed by the results. Point Bridge can certainly be claimed to be the first successfully stiffened suspension bridge in the world, and considering its magnitude, together with the design and workmanship, is and will remain a model of an engineering structure.

All the parties witnessing the test expressed their astonishment about the rigidity of the structure, and wish a lease of life for the time this structure will remain an ornament to the city.

After this was over the company repaired to Mr. Painter's office, where they were served with a sumptuous repast.

This bridge project has occupied the attention of the public more or less for many years past. The South Side embracing a large urban population, and with good river frontage for manufacturing purposes, has long felt the need of a better avenue of communication with the two cities than was afforded by the ferries. An effort was made some six years ago to more intimately connect the detached portion of this one great commun ty intersected by the three rivers by the erection of what was called the tripartite bridge—one arm resting on south bank of Ohio, another on the Allegheny bank, and the third on the Point at the junction of the Allegheny and Monongahela with the other.

Mr. Charles Davis, the consulting engineer of the present company, submitted plans for that improvement which were approved by a company formed at that time to carry out this enterprise.

The estimated cost of this work was near a million dollars.

The undertaking failed only for want of proper support from parties who were directly interested in the bridge—landholders whose property would be greatly enhanced in value by the proposed connection, had been confidently counted on.

Shortly after, an association of citizens, among whom was the present president of the Point Bridge company, applied for, and obtained a charter for building a bridge from Allegheny to the Point, known as the Union bridge, with Mr. Joshua Rhodes as president.

The work was carried out and the bridge opened for traffic some two years since.

After the opening of this arm from Allegheny, the public saw more clearly than ever the necessity of completing the connection with the South Side.

The city councils made some endeavors in this direction, but did not succeed in reaching any practical plan—the lowest figures named in this connection were about one million dollars, which, of course, precluded the possibility of success.

A few prominent citizens, believing the accomplishment of this project would be a great advantage to the city, organized a company and procured a charter. The charter dates December 26, 1874.

The directors and officers of the company are as follows: Directors—R. F. Smythe, H. Darlington, A. E. W. Painter, Henrici, Robt. Marshall, Robt. Stevenson, Joshua Rhodes, president; R. W. McConnell, secretary; Geo. Crook, treasurer; Chas. Davis, consulting engineer P. F. Brendlinger, resident engineer.

The difficulties encountered in the beginning of the undertaking can hardly be understood or appreciated by parties not directly connected with the work. The navigation interest exercised almost absolute control over the river, and was not to be conciliated by any measure short of one granting it an uninterrupted channel of the natural breadth of the river, and with head room to admit of the largest sized boats passing under the bridge at an ordinary boating stage, for manœuvering their coal fleets. With such unreasonable conditions, and with the unfavorable topography of the banks in front of the city, it was no easy problem to make a design that would not obstruct the river, and at the same time give easy grades for the approaches to the bridge. The short level on the Pittsburgh side being only 27 feet above low water, while on the south side the bank comes abrupt against the water line, with a railroad cutting its face and at an elevation of 70 feet above the river bed. The consulting engineer prepared no less than four plans to endeavor to harmonize the different conflicting interests and at the same time to get a practicable and economical construction. The president and consulting engineer of this company was before the coal exchange on several different occasions on this business; and only after several protracted interviews were they enabled to reach an agreement on the present plan. All these conflicting elements had to be harmonized in carrying out the design of and construction of the bridge.

Under ordinary circumstances bridging the Monongahela would have been of trivial importance.

The plan adopted would have necessitated an artificial approach on the north side of a depth of some fifty feet at the abutment and some six feet deep at the foot. The approach is about 1,000 feet long, and extends along the wharf outside of Water street to Penn avenue, and along Penn avenue to Point alley, giving an easy ascent to the bridge. An approach connecting the two bridges will be formed by filling up the Point. The plans for the work were approved in May, 1875.

The Point Bridge company invited bids for building the bridge in May of 1875, with the understanding that they might be for cable suspension, according to specifications and plans prepared by their consulting engineer, which called for an 800 feet middle span and two independent side spans of 145 feet each or for any other plan. Proposals were made by most of our most prominent bridge builders of the country, among whom were Roebling Sons and the Keystone Bridge company of this city, based upon various plans, viz: Cable suspension, braced arch, Ordish system, cantilever, unstiffened and stiffened chain suspension. In selecting the proper plan the directors and engineer of the Point Bridge company were well aware that their bridge was of unusual dimensions and they took care not to adopt an experimental plan. The only long span bridges in the world to compare with the requirements of the Point bridge were the Niagara railroad bridge and the Cincinnati bridge, both being wire-cable suspension, built by Mr. John Roebling, with 820 feet and 1057 feet spans respectively, and the chain suspension bridges—one the Clifton bridge over the Avon, in England, 702 feet long, and the one across the Danube at Pesth, Austria, which has a span of 666 feet—all other long span bridges being either of less length or are only built for light traffic. The plan finally adopted was a stiffened chain suspension bridge, submitted by the American Bridge company of Chicago, and designed by their chief-engineer, Mr. Edward Hemberle. This plan represents all the good features of a modern chain suspension bridge and has, in addition, a novel stiffening system, which, as far as theoretical investigations and judgment can determine, seems to obviate all the faults of wire-cables and of the formerly built chain suspension bridges.

In ordinary suspension bridges the roadway is suspended by hanging rods from chains or cables which stretch from pier to pier. In such a structure the chains or cables and the platform are flexible longitudinally, and this is shown whenever the bridge is loaded at one end more than at the other by a moving load, or is subjected to wind pressure from above or below. To improve the suspension bridges in this respect has been the aim of many engineers. The simplest improvement has been effected by keeping the points of the curved chain or cable which are more liable to deformation in their proper places by attaching them to the top of the towers by straight chains or wire-rope stays, which plan was first adopted by Ordish in Europe and by Roebling in this country.

A method for rendering the chain itself rigid has been attempted by dividing it into two parts, placed one above the other and bracing them together. A railway bridge upon this system, with a span of 260 feet, is in actual use in Vienna, in Austria, but would not be efficient for a long span. A system according to which a single chain is connected to the platform of the roadway by bracing was adopted in the construction of Lambeth bridge across the Thames in London, having spans of 180 feet, built in the year 1862, and in a footway bridge over the Main at Frankfort, Germany, of 262 feet span in 1869. This system properly improved may fulfill all the requirements to ensure stiffness; but in long spans the bracing between roadway and chains will have to be of such great length as to make it ineffective and expensive.

Mr. Hemberle's plan, as represented by Point bridge, consists of towers, chains with platform suspended therefrom in the same manner as in a regular chain suspension bridge; In addition thereto is a stiffening system above the chains, and are rigid posts arranged between chain and platform to prevent the roadway to undulate or oscillate independent of the structure above. The stiffening arrangements above the chains consist in rigid chords running in straight line from the top of the towers toward the center of the chain, and being connected thereto by a hinged joint at each end. Between these chords and the chains is a system of bracing, consisting of posts and diagonal tie-rods. All connections are pin-jointed. The chain, being a catenary or curve of equilibrium, takes up all the permanent load of the structure, without bringing strains on the stiffening trusses. This object was accomplished by erecting the bridge completely before connecting the ends of the straight top chords to the center joint. The rods are provided with turn-buckles, and are so adjusted as to be strained under moving load only.

When the bridge is half loaded the top chords of the trusses on the loaded side will be in compression and the unloaded side in tension. There are lateral and vibration braces between the top chords and also between the chains, proportioned to take up the strains from wind-pressure upon the strains and trusses.

A model of Point bridge was exhibited at Philadelphia and received an award, and Mr. Hemberle was the recipient of quite a number of complimentary letters from most prominent American and foreign engineers approving his new plan.

The total length of the Point bridge is 1,245 feet from back to back of the anchorages, with one middle span 800 feet between center of piers, and one independent trussed side span of 145 feet in length at each shore. The roadway rises from both shores toward the center of the channel with grades not exceeding 3½ feet in 100—the highest point of the roadway being 83 feet above low water. The saddles upon which the chains rest on top of the towers are 180 feet above low water. The deflection of the chain is 83 feet—which is considerably more than usual for suspension bridges—but the stiffening allows of increasing the deflection and thereby reduces the strains in the chains and their weight. The bridge is 34 feet wide from center to center of outside rails and the space is divided into a roadway 21 feet wide and two sidewalks of 6½ feet each by inside iron handrails. The piers up to the roadway and the anchorages are built of masonry. They are founded upon timber platforms sunk to a gravel bed below low water. The masonry is of the best quality—Baden sandstone laid in cement mortar.

The towers are entirely of wrought iron except the bases of the columns. Four columns each 30 inches square braced together by lattice work form the support for each chain, which are carried at the top of the towers on wrought-iron saddles, which are movable on steel rollers to allow for expansion and the elongation of the back chains under strain or from changing temperature.

The chains are formed of link bars, 20 ft. 6 in. long, varying in size from 8 by 2 inches to 8 by 1 inch, connected by pin bolts 6 inches in diameter. There are 12 and 13 bars alternately in the back chains, and 11 and 14 bars in the main chains. Stiffening trusses on top of the chains are 22 feet high in the middle and their upper chord is box-shaped with full rivet splices to resist tension as well as compression.

Outside of the floor are roadway trusses 8 feet high, part above and part below the floor. They are built continuous, in lengths of 100 feet, and are jointed together at their in-ends in such a manner as to allow for expansion and contraction of the iron work. These trusses are suspended from the chains by iron rods placed in pairs every 20 feet and by rigid posts every 100 feet. Iron cross girders, 3 feet in depth, connect these roadway trusses every 20 feet and support two intermediate lines of iron stringers. These stringers and the roadway trusses form the bearers across which are placed the wooden joists for the flooring.

The roadway consists of two courses of 2½ inch oak planks, the lower course being laid diagonal and the upper lengthwise to the bridge. Two street-car tracks are laid upon the floor. The side-walks are laid with narrow 3-inch plank of southern pine. The lateral stiffness of the floor is secured by a double system of tie-rods and the wind pressure is taken up by four horizontal steel wire cables, placed under and connected to the floor.

The specifications for the Point bridge call for a moving load of 1,600 lbs. per lineal foot, to be carried by the structure in addition to its own weight, with a factor of safety of 5, that is, it would require five times the above load to break the bridge down. The 1,900 lbs. per lineal foot is for the 800-feet span, equal to 1,280,000 lbs. which weight is equal to 16 locomotives or equal to the weight of a crowd of 9,000 good-sized people. Such a load is very unlikely ever to come on the middle span of the bridge, and five times that load would not injure the iron work. The back chains on each end of the bridge have a sectional area of 384 square inches, and were all put to actual test of 10 tons per square inch without showing any injury, which will make their reliable supporting power equal to 3,840 tons. For the floor system and the suspenders the proof load is taken at 896 tons for the middle span.

There are 156 suspension-rods carrying the floor, each with a strength of 47 tons, as proved by actual tests which will make their supporting power equal to 7,132 tons, which is equal to the weight of 180 locomotives.

Each of the towers has a sectional area in columns of 504 square inches, and their resistance against failure under the load would be equal to 10,080 tons, whereas the load which ever may come on is only 1,800 tons.

The lateral cables under the floor are at each side, double 2½ inch cast-steel wire ropes, each having an ultimate strength of 210 tons. They would resist the greatest strains brought sideways against the bridge in case of a hurricane, and the bridge has already, under severe winds, proved to be absolutely rigid sideways.

The total cost of the bridge is about $525,000, which is very low compared with other structures of the same magnitude: Cincinnati bridge, being only 200 feet longer, cost $1,800,000. The chain suspension bridge at Pesth, Austria, having a middle span of 666 feet only, cost $2,700,000. St. Louis railway bridge, having spans of 520 feet, cost seven millions.

The president and directors of the Point bridge company deserve great credit for the manner in which they conducted this enterprise. It is due to their efforts and management that this bridge was finished in such short time and at so small cost compared with other bridges in this and other countries.

The American Bridge Company of Chicago, H. A. Rust, president, presented not only the best plan, but also were among the lowest bidders, and the contract was awarded to them for the whole structure complete. The American Bridge Company transferred the contract for the masonry and the foundations to John Megraw, of Allegheny, who has done his share of the work in the most satisfactory manner, and is right in claiming to have the best job of mason work done along our rivers. The award of the contract to an outside company created quite a feeling amongst the Pittsburgers, who are right in claiming their superiority in manufacturing of iron-work, and it may be quite a satisfaction to them that after all most of the work has been done here, with the exception of the forged link-bars in the anchorages and parts of the iron-work, for the manufacture of which the American Bridge Company have special tools in Chicago, all the iron-work was manufactured by Pittsburg parties. Graff, Bennett & Co., furnished the iron in quality unrivaled for the purpose. It is superior in strength and other qualities required for bridge iron to the manufacture of parties making bridge iron their specialty. Mr. Williams, the superintendent of their mill, deserves a great deal of credit for his efforts in obtaining for the unusual large bars a quality of the iron in strict conformity with the specifications.

The manufacture of the iron-work was done at the Pittsburg Locomotive-works, under the supervision of the American Bridge Company's agents. The manufacture of the large link-bars was, after some experimenting, brought to perfection, so as to insure the same strength throughout the entire bar and eyes, which before has been only obtained by the process of Mr. Sellers at Edgemoor.

On July 1, 1875, work was commenced, and by the following winter the masonry was well advanced. Early

in the spring operations were again resumed and continued without interruption to the present date. A great deal of the most difficult work, such as the stiffening-truss, was prosecuted in mid-winter, with the thermometer ranging near zero, and with heavy winds prevailing. Much of the time the material was covered with snow and ice. The rough weather severely taxed the endurance of the men, but in no instance did it get the mastery. Much credit is due Mr. George C. Thorn, superintendent of erection, for the masterly manner in which he conducted the work through such adverse circumstances, and without the occurence of any accident.

The specifications were drawn with considerable minuteness, and required very rigid tests for iron. The links were to be made of the best quality of double refined iron, and in addition to other tests were submitted to a proof strain of ten tons per square inch, sectional area, before they were admitted into the chains. This testing, as well as the inspection of the work, and the giving of levels and distances connected with the bridge, in compliance with the specifications, was intrusted to the resident engineer, who was also the estimating engineer.

The records of the iron test have been carefully preserved, and form a valuable record.

The quantities of the material used in the construction of the bridge are as follows, viz.:

Timber in foundations, 1,442,000 feet, board measure.
Masonry in anchor-walls, 10,868 cubic yards.
Masonry in piers, 7,507 cubic yards.
Iron in foundations, 12 tons.
Wrought-iron in superstructure, 2,084 tons.
Cast-iron in superstructure, 52 tons.
Steel in superstructure, 32 tons.
Timber in superstructure, 810,000 feet, board measure.
Number of links in the chain, 1,832.

As an immediate result of the building of the bridge we should note the approaching completion of the Duquesne Inclined Plane, designed to overcome the gradient of Coalhill, and so situated as to connect with the Point bridge. And yet another, in the proposed street car railway, starting from Fifth avenue and liberty street then along either Penn or Duquesne way to the bridge, across the bridge to Carson street; along the same to Saw-mill run and continued to the Old S one tavern.

The Point Bridge Company are already engaged in constructing a portion of this line connected with the bridge and approaches on their own account.

Also another improvement, diverting travel through new channels, in the shape of a proposed freight and passenger depot for the Panhandle R. R., at the terminus of the bridge.

It is impossible to calculate the benefits to be derived by the different portions of the city in the increased facilities for intercourse afforded by the erection of this bridge. It will undoubtedly restore the old part of Pittsburg about the Point to its former vitality, and will greatly contribute to the speedy development of heretofore almost inaccessible territory on the South Side. By such schemes of internal improvement as this, the thrift and general prosperity of the city is enhanced, and additional comforts to the citizens secured.

And we have no doubt that the parties interested in the construction of the bridge will be amply repaid in this investment.

The bridge will not be open for general traffic before ten days, the approaches not being finished yet. The bridge itself is completed, except the finishing of the hand-rails and the ornamental work of the towers. The ornamental work of the towers will be done quite elaborately and it will greatly add to the beauty of the structure. It is to be of galvanized iron, and the work, already done by Messrs. Stevenson & Cartwright, of Allegheny, awaits only good weather to be put in place. Two more coats of paint are to be put on the bridge as soon as continuous good weather can be expected.

CORRESPONDENCE.

GALVESTON, TEXAS, *April 7, 1877.*

Editor ENGINEERING NEWS:

SIR.—In view of the approaching annual meeting of the American Society of Civil Engineers at New Orleans this month, a few words about Galveston may not be out of place.

Engineering is not flourishing in Texas, although perhaps it is less affected by the hard times here than elsewhere. Many Civil Engineers in this State are out of employment, and more are daily arriving from neighboring States, hoping to find a little relief from the general depression of business prevailing everywhere.

Numerous railroads are being projected throughout the State, but the failure of Congress to aid the Texas & Southern Pacific Railroads has discouraged our capitalists. Galveston, not to be behind other cities, has a three feet guage railroad running some nine miles down the island. It is known as the "Hurly Narrow Gauge." Our city fathers are considering the, by no means easy, problem of how to supply the city with fresh water and water works. Also the completion of a system of sewerage which shall utilize the tide water of the Gulf for flushing and cleansing; the same that was approved by Gen. Beauregard and commenced by Gen. Bragg several years ago. But owing to a heavy municipal debt, and lack of ready funds, it may be some time yet before these problems find a practical solution.

Chas. Morgan, of New York, one of the most enterprising men of the day, and the owner of a large line of steam ships running from this port to New Orleans, New York, Havana; and many other points, has just purchased the controlling interest of the Texas Central R. R. He has already spent nearly a million of dollars dredging a twelve foot channel through Galveston Bay, to connect this line at Clinton, Texas, with his steam ship lines. The work is not nearly completed as yet, but the general government is making surveys preparatory to taking charge of it and making the whole channel, now subject to heavy tolls, open free to all commerce.

The government is now trying a new plan for the improvement of our harbor by means of "Gabions." This very cheap and novel method is due to Capt. C. W. Howell, U. S. A., who first recommended its trial. As you have already given some account of this on p. 267, vol. III. of the NEWS, I postpone comments until further progress has been made. Owing to limited appropriations and the holding back of the greater part of the same last year, but little progress on this work has been made. Recently, however, the balance of last year's appropriation has been made available for the work, and undoubtedly the coming year will go far to prove the success of the experiment. I understand arrangements have been make with the Morgan Line between New Orleans and Galveston, which will enable members visiting New Orleans to also visit Galveston, and return free of charge, so that parties wishing it can have an opportunity, seldom offered, to examine for themselves the merits of a new idea.

In conclusion I would say that a cordial invitation is extended to all members of the society to visit us, and we promise to do what little we can to make their stay among us as pleasant as possible. J. A. HAYWARD.

JACKSONVILLE WATERWORKS—EXTENSION OF TIME.

JACKSONVILLE, FLA., *April 6, 1877.*

Editor ENGINEERING NEWS.

SIR.—Owing to short notice several parties desiring to bid on Water Works requested more time, and there being but few bids in, the Council postponed the matter and have not yet fixed the day of extension.

Yours, etc., T. E. BUCKMAN.

NEW TACOMA, WASH. TER., *March 28, 1877.*

Editor ENGINEERING NEWS:

Permit me to say a word on the pleasure and profit I derive from reading your paper. "May its shadow never grow less." The efforts you have been making towards elevating the professional standard of engineers ought to have the sympathy of every true man; of every one who has an interest in our noble profession. Certainly it ought to encourage us who are younger to labor earnestly in order that we may worthily be counted a member of such a brotherhood. My best wishes for the success of yourself and the child of your care, *i. e.* the ENGINEERING NEWS. Yours truly, D. D. CLARKE.

QUINCY, MASS., *April 5, 1877.*

Editor ENGINEERING NEWS:

SIR.—Business seems to be picking up a little. Most engineers are having considerable work it seems. Pawtucket, R. I., is to introduce the Holly system of water works. Surveys are being made for thirteen miles of railroad, connecting Southbridge on the New York & New England Railroad with Brookfield on the Boston & Albany. The prospect is very good for a narrow gauge railroad in Vermont, from Brattleborough to Whitehall. Brookline, Mass., has voted to build a large trunk sewer this summer. It will empty into Charles River at present, but connect with the Boston system at some future time. Wm. S. Barboun is re-elected City Engineer of Cambridge. Architecture is better now than it has been for some time. Yours truly, C. H.

WAUKEGAN, LAKE CO., ILL., *April 7, 1877.*

Editor ENGINEERING NEWS:

SIR.—Enclosed find amount of subscription for ENGINEERING NEWS. Old as I am, I find in each number something that to me is new. In my opinion it would pay every township in the State to subscribe for ENGINEERING NEWS for the use of Highway Commissioners. Probably there is not one in ten of the Road Commissioners in the State that ever dream there is the least science in making embankments. A pile of dirt—nothing more—no matter how placed. Enough study to make them distrust their own knowledge would induce the taking of counsel, and would save much to the tax payers. Then the permanency of culverts, or their abutments, would frequently be improved, if the road authorities knew the necessities of using good cement instead of common lime mortar, By the way, would it not be well for you, if you have the leisure time to write up the question of building common roads. You might not make much money by it, but the public would indirectly be benefitted by the knowledge that some would thereby gain by coming in contact with your many not always stupid readers. Your journal is an educator of not only professional men, but of all classes who read it, or converse with those who do. I cannot hope that you will receive all the patronage you deserve, but I do hope that you will get sufficient patronage to induce you to continue its publication. Long life to ENGINEERING NEWS. Yours truly,

H. W., *County Surveyor.*

OBSERVATIONS UPON SEWERS AND FORMULÆ.

PROVIDENCE, R. I., *April 7, 1877.*

Editor ENGINEERING NEWS:

SIR.—Assume, which is practically correct, that a sewer 66" circular, is flowing one foot deep in water, the length of arc then will be 4.847 feet area = 2.9515, the H M R = .60958, and the grade 1 in 1000. Neville makes the velocity = 3.46 − .93 = 2.53 per second; and Molesworth gives 1.860; Eytelwein 2.3466, very near Neville. It commences to rain heavily, and the sewer is filled to within 18" of the crown, then the area of water = 18.50 sq. feet, and V = 4.38 Neville; Molesworth 2.6; and Eytelein 3.86. So there is considerable difference between the three, but Neville gets very near what I should think the actual result. The area of the water will then 18.50, wetted perimeter 11.234, and H M R 1.647, making the discharge 4866.2 cubic feet per minute. Now there are running into this sewer seven 20", ten 22", one 12", and according to the formlæ, $D = \left\{ \frac{m^2}{1450\,S} \right\}^{\frac{1}{6}}$ the 20" sewer will drain 16 acres with a grade of 1 in 500 which is very near their grade; also the 22" will drain each 22 acres, and the 12" pipe 10 acres, making a total of 166 acres.—this is allowing for one inch to be raining per hour and half getting into the sewer, and the amount of water flowing would be $166 \times 30\frac{1}{4} = 5021$ feet which is very near the amount given by Neville as above, and taking the whole sewer running full the discharge would be 7227.8 cubic feet per minute, or 239 acres, condition as stated. But Roe says in his tables that a 60" sewer level will drain 570 acres—over twice as much, and I cannot understand how this is, nor yet how Mr. Ryall, in Jan, No. 13, can put Roe into a formulæ; for if you plat the table, you get an irregular curve, $D = \left\{ \frac{m^2}{S\ 1450} \right\}^{\frac{1}{6}}$ gives 40 acres nearly, as the amount this sewer will drain, against 239 acres which would be got by Neville, and one supposed to by Bazalgette gets $\frac{3 \log A + \log N + 6.8}{10} = D$ in inches, giving in this case 629 acres, something like Roe's tables. Now all the formulæ I have seen have to have a grade or the quantities become infinite. Now if we take

$$D = \left\{ \frac{m^2}{1450\,S} \right\}^{\frac{1}{5}}$$

we get 171 acres, and why such a change should be made to the extent given by Mr. Clark, of Boston, in the same No. of Jan. 13, that the house connections and gullies give a greater velocity to the water, when my experience is the other way. Baldwin Latham says he has known sewers surcharged by lateral drains having a steeper grade, and I can quote lots of these cases, and in answer to Mr. L. L. Nichols, March 24th, I should say that $D = \left\{ \frac{m^2}{1450\,S} \right\}^{\frac{2}{5}}$ is the nearest the truth.

W. W.

FULTON, MO., *April 5, 1877.*

Editor ENGINEERING NEWS:

SIR.—Will any length of time legalize corners illegally established by a County Surveyor (that is, contrary to the instructions from the Commissioner of the General Land Office, and the Statutes of the State), and justify his successor in office in adopting such corners as correct, when he knows them to be wrong, and divide up sections from said corners? Would like to know your opinion, and that of some of your correspondents, at the earliest possible time. COUNTY SURVEYOR.

Acquiesence for a long time (*e. g.* for 18 years) even in erroneous location, is conclusive on the party making or acquiescing in such location. Rockwell *v.* Adams, 6 Wend, (N. Y.) 469.

Where a boundary is disputed between parties who own adjoining tracts, and the parties employ a surveyor, who runs out the line, and marks it in a plat in their presence, as a boundary, after *20 years* corresponding possession, they are concluded by it. Boyd *v.* Graves, 4 Wheat. 53.

Fifteen years acquiesence in an imaginary divisional line between adjacent proprietors establishes that line as a boundary. Beecher *v.* Parmele, 9 Vermont, 352.

A division line which has been agreed upon for *thirty* years, cannot be altered. Chew *v.* Morton, 10 Watts. (Pa.) 321.

The *original* surveys by which the government sold its land and conveyed it to the purchaser, establish the right of the parties as to the boundaries. No line which will vary the rights thus acquired, can afterwards be established, *without consent* of all parties. May *v.* Buskins 12 S. & M. (Miss.) 428.

So, in trespass against the defendant for removing the plaintiff's fence, proof that by the Government Surveys the fence was on defendant's land cannot be affected by proof of other surveys, not conforming to the Government Surveys. *Ibid.*

The simplest and most easily comprehended system of subdividing large tracts of land is the Rectangular; the rules for relocation of missing corners are very distinct, and it is only through gross carelessness or ignorance that errors in surveys are allowed to be fastened on a neighborhood to entail endless and vexatious litigation. The opinions which we have recited above show that a long period of acquiescence in an erroneous survey fixes the boundary line laid down by such; it does not, however, affect adjoining sections, or as we understand it, the sub-division of the section in which said erroneous boundary is. In our own practice we always have held to one principle—*to stick by the government,*—and in the establishment of disputed boundaries we try to get as nearly on the identical track over which the Government Deputy's chain was dragged as we possibly can. His route is mapped out by the Government who has also put down in plain figures the distances between his half-

mile and mile halting places, and by innumerable decisions from its highest officer has established the method of comparing the measurements of succeeding surveyors and those of the Deputy. We hold then that mutual consent between adjacent proprietors may establish a line between *their* lands; their action does not affect the boundary line of other portions of the same section, and in making surveys thereof we would simply ignore all such agreed-upon lines, determine by measurement or evidence the location of original monuments as nearly as possible, and pay no attention to the mistakes of a former surveyor. Get as near to the court of last resort as possible,—and that is the Government.—[Ed.

NOTES ON THE FORMULÆ FOR STRENGTH OF COLUMNS.

COLUMBUS, OHIO, *April 5, 1877.*

Editor Engineering News:

Sir—The difference between Hodgkinson's and Gordon's and Rankine's formulæ seems to have given rise to an error which has become so wide-spread among the profession as to require some notice.

Hodgkinson obtained from his experiments on iron columns the following formulæ for solid columns of cast iron:

$$W = \frac{d\ 3.6}{L\ 1.7} \times 44.16 \text{ for square ends.}$$

$$W = \frac{d\ 3.6}{L\ 1.7} \times 13.0 \text{ for rounded ends.}$$

Subsequently he modified these formulæ as follows:

$$W = \frac{d\ 3.5}{L\ 1.63} \times 42.3 \text{ for square ends.}$$

$$W = \frac{d\ 3.76}{L\ 1.76} \times 14.9 \text{ for rounded ends.}$$

In all of which W = breaking load in tons.
d = diameter in *inches.*
L = length in *feet.*

Gordon's formulæ, derived from the same experiments, are:

$$W = \frac{f\ s}{1 + a\frac{l^2}{h^2}} \text{ for square ends.}$$

$$W = \frac{f\ s}{1 + 4a\frac{l^2}{h^2}} \text{ for rounded ends.}$$

These formulæ were subsequently modified by Prof. Rankine as follows:

$$W = \frac{f\ s}{1 + a'\frac{l^2}{r^2}} \text{ for square ends.}$$

$$W = \frac{f\ s}{1 + a'\frac{l^2}{r^2}} \text{ for rounded ends.}$$

In both Gordon's and Rankine's formulæ
W = breaking load in *lbs.*
f = modulus of resistance to crushing.
s = area of section.
a and a = co-efficients depending on the material.
l = length in inches.
h = least dimension of cross section.
r = least radius of gyration of section.

The error to which we have alluded is this: Hodgkinson's rule makes the strength of rounded ends *about one-third* that of square ends; and this ratio seems to have become so firmly impressed on the minds of the profession that they cannot get free from it; and while most engineers have discarded Hodgkinson's formulæ in favor of the others, yet this ratio *one-third* is frequently applied while using Gordon's or Rankine's formulæ for square ends.

If we transpose Gordon's formula for square ends, so as to get the area (s) in the left hand member, it becomes

$$s = \frac{P}{f} + \frac{P}{f}\ a.\ \frac{l^2}{h^2}$$

which, being interpreted, means that the area of the cross-section must consist,

First. Of a portion $\frac{P}{f}$ to resist *crushing*, and which is entirely independent of the *form* of section, and length of column, and which for a given load is constant for all ratios of length to diameter.

Second. Of an additional portion to resist *bending*, and which depends on the form of section and ratio of length to diameter.

The resistance to bending, as between round ends and square ends is analogous to the difference, in the resistance of a *beam* with fixed ends, and with ends resting on supports; hence the use of the factor 4 in Gordon's and Rankine's formulæ, as applied to round ends. But this factor applies only to that additional area required to resist bending, and not to the area which resists crushing.

The ratio of strength of square end and round end columns, is therefore a variable quantity; the difference increasing as the ratio of length to diameter increases, and diminishing as this length-*ratio* decreases. By Gordon's rule the ratio is greater than 75.

Thos. H. Johnson, C. E.

The success of the steam street cars in Philadelphia seems to be assured. During a single week the receipts of five horse-cars averaged $65, while those of five dummies averaged $100. The average expense of a horse-car during that period was $62 86; that of a dummy $54 80.

ON THE PROBABLE ERRORS OF LEVELING; WITH RULES FOR THE TREATMENT OF ACCUMULATED ERRORS.*

BY WILFRED AIRY, B. A., M. INST. C. E.

(*Continued from page 84.*)

Table VI.—Instruments and Staves used in Initial Leveling.[1]

Instrument	Great Britain.	India.	Switzerland.	France.
Spirit level..... Seconds of arc in tilt of telescope corresponding to 1-inch of the bubble run of the bubble.....	5"	3½"	3"	3" to 7"
Telescope..... Focal Length..... Object Glass.	24 ins.	21 ins.	16 ins.	19 ins.
Diameter of Object Glass.	2⅝ "	2 "	1¼ "	1¼ "
Magnifying power.....	50	42	42	36
Staves..... Length.....	10 ft.	16 ft.	9.84 ft.	6.100 ft.
Graduated to.....	1-100 ft.	1-100 ft.	3-100 "	3-1000 "
Read to.....	1-1000 "	1-1000 "	3-1000 "	3-1000 "
Maximum distance of staves from Instrument.....	5 chs.	10 chs.	5 chs.	6½ chs.

[1] The metrical values of the foreign measures have been reduced to English units for the sake of comparison.

By due attention to all the ascertained causes of error a high degree of accuracy may be secured, and this Paper cannot better close than with a reference to the astonishing results obtained in India under the able management of Colonel Walker. From the Report on the Spirit Leveling Operations in India dated 1866 the following information is extracted:—

Section.	Length.	Maximum Divergence of two observers.	Terminal Divergence.
	Miles.	foot.	foot.
Calcutta to Tilliagarhi....	242	.20	.15
Tilliagarhi to Patka Gerouli.....	346	.40	.38
Agra to Patka Gerouli ...	342½	.15	.05

Sir. G. B. Airy, Astronomer Royal, observed that, although he had run a few miles of level himself, he could not make any practical notes upon this communication; but he would say one thing, that, referring to the state of knowledge upon the matter as it was some years ago, something of this accurate character was much wanted. On one occasion he wished to know how far reliance could be placed upon the levels between Manchester and Runcorn, and applied to an engineering friend, who did not profess to be able to answer the question accurately, but referred to three others who were considered likely to be perfectly informed upon the matter; and one of these gentleman said he thought the levels might be trusted to 6 inches, another put it at 2 inches, and the third at 1 inch. That was the state of things some years ago. No doubt they had grown better now; but still he was pleased to hear that there was an attempt at getting greater accuracy on this point, and by a collection of the best measures. Amongst those that had been brought together was that of Switzerland, with which, although less extensive than those of Great Britain and India, extraordinary pains had been taken. He had the good fortune to be personally acquainted with M. Plantamour, who was at the head of that, as well as with the officers at the head of the two other surveys, and he was quite sure that, in Switzerland, everything was done which could be done by men careful and well acquainted with the mathematics on the subject. As far as he could remark, there was but slight mention in the Paper of one of the discoverable errors, namely, that constant error which produced a difference in the apparent levels according as a line was leveled in one direction or in the opposite direction. This had excited attention a number of years ago on the occasion of leveling from the English Channel to the Bristol Channel. Amongst other causes assigned, he did not know whether there had been an allusion to the possibility of an error from the possible circumstance—for he was not sure that it was a real one—of always reading the front staff before the back staff, or the contrary; it was conceivable that that should cause such an error. With regard to the mathemathies of the case, as applying to a geodetic survey, he was glad they were brought into shape, and he would point out the nature of the mathematics concerned. Supposing that leveling was effected in a triangle between these stations; it was to be expected in all cases that there would be some degree of inconsistency; but by proper treatment, understood by practical men, the determination of the most probable errors amongst them could be laid down, and the way in which the inconsistency should be divided between the three stations. In another triangle, or a trapezium or polygon, the same could be done there; but suppose those were connected by other levels which joined one of the figures to the other figure, the problem was immediately changed. Neither of those could be treated separately if they were joined by leveling from the stations of one to the stations of the other. The problem came within the case which in a little book that he had written upon the subject, he had called 'entangled errors,' and admitted of accurate treatment leading to a definite result in every case. The best thing, therefore, that he could do was to recommend engineers to read his book.

Mr. Longridge said, although the Paper might not be of much general use to Civil Engineers, it was still one which in the higher operations of leveling, so necessary for other purposes, must be of great value. In their operations engineers did not require that extreme accuracy which called for the treatment of the subject in the way in which it had been dealt with by the Author. If the system of leveling was carried on with tolerable care, and properly checked, they would arrive at results which were quite as accurate as was required for such purposes as waterworks, canals, and railways. He was surprised that any engineer could have told the Astronomer Royal that between Manchester and Runcorn there might be as much difference in the estimated level as 6 inches; for in the days of the Liverpool and Manchester railway, when the instruments used were not like those of the present day, but something more like a mason's level, he did not believe engineers got further wrong than 6 inches. In his own early days, when leveling the North Midland railway, the system adopted was that the levels were checked by another person. If a difference was found of 2 inches in a distance of 30 miles, the work had to be done over again, and he could safely say in a distance of 30 or 40 miles, if the levels did not check within that limit, the work was thought very bad indeed. If the ground was rough, there might be loss in going up hill; but the gain would be as much in going down, although it was quite true there might be an error at the top of the hill. Another error spoken of was that arising from the staff not being held vertically. Formerly the staves were made with levels and plum-bobs in them. That, however, was perfectly unnecessary, and the only thing required was to instruct the staff-holder, when he held up the staff, instead of keeping it perfectly vertical, to move it backwards and forwards. The lowest level could then be read off. Another cause of error was from shifting the staff. To obviate that, he had small tripods, which the staff-holder pressed with his heel into the ground and held the staff on, so that the staff was not shifted, but was simply turned round. No doubt all these details were well known to practical men. Referring to leveling instruments, he wished to mention one he had used with great advantage for some years, particularly in rough ground. It was, he believed, devised by Mr. Metford, and was made by Pastorelli. It differed from the ordinary level in not having parallel plates, but instead a ball and socket and three screws. The level had a circular bubble as well as an ordinary bubble, and it was set by using the ball and socket. Directing it upon the staff it could be set almost exactly right, the bubble being adjusted by the slightest pinch upon the screw. It was done in a moment, instead of having the four screws to adjust, which was tedious on rough and sidelong ground. He believed a third of the time might be saved on rough ground by using such an instrument; and he therefore recommended it to those who wished to get through their work quickly.

Mr. Barlow, Vice-President, thought Mr. Longridge had hardly caught the sense of the Paper. There were sources of error, if he understood the Author, which could not be got over by checking by any person, arising, for example, from leveling from point A to B as compared with leveling from B to A. The Astronomer Royal had mentioned the levels taken from the British Channel to the English Channel—from Portishead to Axmouth—a distance of 74 miles. The instruments used were of the most perfect class, and the levels were done with every possible pains that could be taken for such work. The levels were taken for a Committee of the British Association, under the immediate direction of Professor Whewell, and in that case an error had been made at the end, comparing the levels taken from north to south with those taken from south to north, exceeding 1 foot. Starting from the northern end in a distance of 12 miles, there was an error of 35-100 foot; in 27 miles, 57-100 foot; at 43 miles, 75-100 foot; and in the whole 74 miles, 1 3-100 foot. The gradual manner in which that error occurred from one end to the other showed there was something beyond that which ordinary levels professed to check.

To be continued.

* From the Proceedings of the Institution of Civil Engineers, London.

THE STRENGTH OF COLUMNS.

The letter of our correspondent, on page 92 of our last issue, has called the attention of our readers to the formulæ for the strength of iron columns as commonly used, and, both for the sake of more strongly insisting on some of the points there brought out, as well as to present the formulæ in a little better shape than that in which the printer there set them forth, we have thought best to devote a little more space to the matter.

The formulæ of Mr. Eaton Hodgkinson, as published by him in 1840, in the *Philosophical Transactions*, and in 1846, in *Experimental Researches on the strength and other properties of Cast Iron*, were practically of the form

$$\text{Breaking load} = A\,\frac{hm}{L^n},$$

in which the breaking load is given in tons, h is the diameter in inches, L the length in feet, and A a constant multiplier in tons. The exponent m is sometimes given, for cast iron, as 3.6, sometimes as 3.5, and sometimes as 3.55, while n also varies from 1.7 to 1.63, these number supplying to square ended, solid cylindrical columns. This difference in the exponent is not very material. The multiplier A varies with the quality of the iron, and is often taken as 44.16 tons. Similar formulæ were given for wrought iron, the constant A being materially different and the exponent l being 2. Liberal quotations from Hodgkinson may be found in the thirteenth chapter of Stoney on the Theory of Strains, and Wood's Resistance of Materials, p. 56, shows how exponents may be deduced from experiment. That a column with both ends free to turn or bend sideways is much weaker than one whose ends are fixed in direction is manifest, if we consider that one with fixed ends must develop upon flexure under a longitudinal force, two points of contraflexure, making the portions between these two points, which alone may be compared with a pillar free to turn on its ends, only half the length of the original column.

But without citing in detail the modification of symbols, in the formulæ written above, as any engineer has access in his books to the quantities referred to, it is proper to call the reader's attention to the fact that Hodgkinson expressly limits his formulæ to cast iron columns when the ends are flat and firmly bedded, whose lengths are more than *thirty* times their diameter, and to wrought iron columns whose lengths exceed the diameter *sixty* times; or, if both ends are rounded, to one half these lengths. For cast-iron columns of medium length, that is, less than thirty diameters, he modifies as follows:— If b denotes the breaking load of the pillar by the above formula, and c the crushing load of a short block of the same sectional area then the

$$\text{Actual breaking load} = \frac{4bc}{4b+3c};$$

which later formula will modify results from the preceding one very materially.

Mr. Lewis Gordon derived a formula from Hodgkinson's experiment which, as given by Prof. Rankine, is, if P denote the crushing load of a long pillar, in pounds, S the sectional area of material in it, and square inches, l its length and h its least external diameter in the same units of measure

$$P = \frac{fS}{1 + a\frac{l^2}{h^2}}.$$

The constant f is understood to be the resistance of the material to crushing, and is given as, for cast iron cylindrical columns 80,000 lbs. per sq. inch, and, for wrought iron regular columns, 36,000 lbs. per sq. inch It is often customary in America to make f for wrought iron cylinders considerably larger, 45,000 lbs. to 50,000 lbs.; a few experiments on hollow columns have confirmed this latter value. If the columns are fixed at both ends, for cast iron $a = \frac{1}{800}$, and for wrought iron $a = \frac{1}{3000}$; if rounded or jointed at both ends use $4a$ in place of a; and, if one end is fixed and the other jointed, Rankine gives in his *Machinery and Mill Work* $\frac{16}{9}a$ in place of a.

Gordon's formula is in general use, and with satisfactory results so far as the sections are concerned for which it was devised. It is not very handy but is the best we have. What our correspondent remarks about the division of the cross-section into a portion to resist crushing and a portion to resist bending is well stated. That a formula of such a shape might be expected to apply may be concisely shown in the following manner:—The *effect* of a load on a pillar may be divided into two parts, first, a direct thrust giving a uniform compression on the fibres $= p' = \frac{P}{S}$; second a bending moment causing the pillar to yield in the direction of its least dimension, h. This decomposition is that of a force at a distance from an axis into a force and a couple at the axis. This bending moment, at the point of maximum deflection of the column from a straight line, may be represented by the expression Pv, where v corresponds with the deflection of a beam under a transverse load. Let the stress on the external fibres due to this bending be p''. Then since the moment of resistance of the column to flexure may be put $np'' = bh^2 = M$, where b and h are the two external dimensions of the cross-section, n a numerical factor depending on the shape of the cross-section, and M = bending moment. We have therefore

$$p'' = \frac{M}{nbh^2} = \frac{Pv}{nbh^2} \therefore p'' \text{ varies as } \frac{Pv}{bh^2}$$

But the greatest safe deflection v varies as $\frac{l^2}{h}$, therefore,

$$p'' \text{ varies as } \frac{Pl^2}{bh^2}, \text{ or as } \frac{Pl^2}{Sh^2}, \text{ or as } p'\frac{l^2}{h^2}$$

hence the total stress on the most strained fibre

$$f = p' + p'' = \frac{P}{S}\left(1 + a\frac{l^2}{h^2}\right) \text{ or } P = \frac{fS}{1 + a\frac{l^2}{h^2}}$$

where a = constant to be found experimentally.

As wrought iron columns are of various sections a formula was desired which would apply to other forms than rectangles. The value of p' in the above demonstration would be unchanged as long so S was constant, no matter what the form of cross-section; but p'', depending on the deflection, would naturally change with the *moment of inertia*, a quantity entering into all calculations of beams. As the moment of inertia may be written = the cross-section multiplied by the square of the radius of gyration—Prof. Rankine sought to introduce this quantity, denoted by r^2, in place of h^2 in Gordon's formula, which would then apply to any section of column. The formulæ as so modified are not understood to be exact, but to be the best we have until experiments are made to supply new and better data. The moment of inertia of a rectangle of height h and breadth b, above an axis parallel to b, passing through its centre of gravity, is $\frac{1}{12}bh^3$. Then, dividing by $S = bh$, we get $r^2 = \frac{1}{12}h^2$ or $h^2 = 12r^2$. Since the original formula applied to a wrought iron strut or column of rectangular cross-section, we may write $12r^2$ for h^2 without error, and we thus give Prof. Rankine's form

$$P = \frac{36000\,S}{1 + \frac{l^2}{36000r^2}}$$

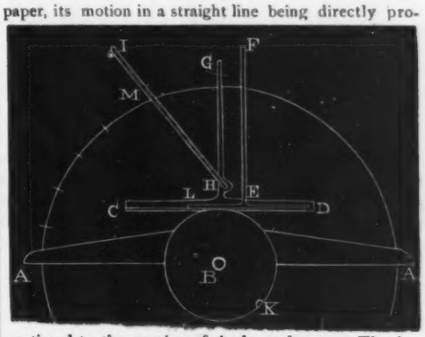
Any other form of cross-section will then be assumed to vary as to strength according to r^2, For **L**, **T**, and **H** sections the original formula is sometimes used with good results when $1\frac{1}{4}l$ is substituted for l.

That some better rules for proportioning columns are needed is very apparent. Prof. Vose gives, in his *"Manual for R. R. Engineers,"* page 143, some of the results for cast iron columns obtained by using the formulæ found in various text and hand-books; the discrepancies are very large. We had hoped that the U. S. Commission for Tests of Iron and Steel would furnish such data as are needed for the establishment of formulæ adapted to American metal and the sections, rolled or built, which are in use; but the failure of Congress to make the much needed appropriation cuts us off, at least for the present, from this source of information. Experiments on full-sized columns, both as to length and section, are requisite, and they are too costly for a private purse. Mr. Chas. Macdonald, in closing his analysis of the Ashtabula Bridge, before the American Society of Civil Engineers, after attempting to arrive at some conclusion as to what the braces (6 inch rolled I beams) ought to carry, remarks, "a careful study of the behavior of the compression members of this bridge must impress us with the necessity of more perfect experimental knowledge of the strength of iron in the form of struts. Almost the only information we now have is crystallized in that somewhat flexible expression known as Gordon's formula, and we have seen how difficult it has been to extract any comfort from it on this occasion."

We have said nothing about the importance of firm, square bearings on the ends of columns, and of the resultant of the pressure lying along the axis of the strut, both very important points. We have only attempted to call attention to the different formulæ, how they are derived, and to the difference between square ended and round ended columns. No ratio of three to one properly expresses their comparative strength In conclusion we would commend, to such of our readers as may have access to the comparatively little known book of Baker's, *"On the Strengths of Beams, Columns and Arches,"* published by Spon, that portion on the Strength of Columns.

CIRCLE DIVIDING INSTRUMENTS.

The device illustrated in the accompanying sketch has been recently invented for dividing a circular arc or an entire circle into any number of equal parts. It consists of a straight edge A A to which is attached a circular disc B; to the same center on which this disc B turns is fastened an arm G H, with a cross head C D in which slides a bar D L carrying at right angles the arm E F. A flat steel wire, fastened at D to the bar, passes round the circumference of the disc and is attached to it at K; other wires fastened at the extremity L pass to K around the other portion of the disc. It is evident then that, as the disc B is turned by the straight edge A, the arm E F will travel parallel to itself across the paper, its motion in a straight line being directly proportional to the motion of A along the arc. The bar H I is hinged on a pin at the end H and has a number of equidistant holes drilled along its length. All of the other parts are sufficiently raised from the paper to permit A A to revolve below them.



To divide a circle proceed as follows:—Place the center B over the center of the circle and retain it there by a pin through the hole at B. If it is desired to begin the division at a definite point, swing A round to the desired point, insert a pin in the hole at the center of motion of the bar H I, and move the arm G H until the pin comes in contact with the edge of E F. Then fasten the extremity G to the drawing board by a projecting point at that end; remove the pin from H and insert it that number of hole, say at M, which corresponds to the desired number of divisions in a semi-circumference or a circumference; swing A A through exactly 180°, causing E F to move toward I, and bringing the other end of A to the point first determined upon. Then move the end I of the bar H I until the pin in its hole at M will bear against the side of E F in its new position. Fasten I in its new location by a pin. The instrument is now set, and it is apparent that a movement of A through 180° will cause E F to move from M to H; hence a shifting of the pin at M to the successive holes in the bar will cause A, when E F is moved, to touch the pin, to pass over the required spaces of arc. For an odd number of divisions of a circle the number of holes may be doubled, and the pin moved over two at a time.

The instrument will also divide any angle in any number of parts. It is expected to be especially useful for laying out teeth of wheels. A patent has been applied for.

In his report to the Common Council, of Chicago, concerning the "Crib," Gen. W. Sooy Smith declares that structure to be in good and safe condition, and he

sees no reason why it will not continue so for many years to come. He states, however, that a protection wall on the side most exposed to the northeast storms would render it still more secure.

THE number for March, 1877, of the "Transactions of the American Society of Civil Engineers" contains three papers of interest; a short one on "A Water Conduit under Pressure," by John F. Fanning; a report by Chas. Macdonald on the "Failure of the Ashtabula Bridge," which is in harmony with the views already expressed in our pages; and a paper on "Co-ordinate Surveying," by Henry F. Walding. All the communications are illustrated. With this number is bound the report of the Chief Engineer, W. A. Roebling, of the New York and Brooklyn Bridge, covering the years 1875 and 1876, with the reports of his assistants. Engineers will find much matter of interest in this latter pamphlet of more than 100 pages.

ON another page we give the table of Contents of Dr. Weyrauch's treatise on the "Strength and Determination of the Dimensions of Structures of Iron and Steel," a little book which is presented to the Engineering profession at a most opportune time. Since the accident at Ashtabula, public attention has been largely drawn to the subject of iron bridge construction, and everything relating thereto is of peculiar interest. This interest is also increasing and it has been found expedient by the managers of our leading railways to investigate the condition of the bridges on their several lines of road. The specialty of bridge engineering may be considered as rising rapidly in importance and to those of our readers who are ambitious of preferment in this branch of their profession we can confidently recommend the treatise of Dr. Weyrauch as almost indispensable in studying the subjects of which it treats. That three such names as Weyrauch, Du Bois and Thurston should be associated in the preparation of a work on this subject is a very sufficient guarantee of its worth, while in the excellence of its mechanical execution together with the low price at which the work is placed upon the market, everything has been done to ensure its extensive distribution among the engineering profession.

Quite a large delegation will go from Chicago to attend the Convention of the American Society of Civil Engineers in New Orleans.

The Secretary of the Civil Engineers' Club of the Northwest has furnished certificates to the following named persons, most of whom will leave Chicago Monday morning via the Illinois Central Railroad:

From Chicago.—E. S. Chesbrough, Mrs. Chesbrough, S. S. Greeley, E. Hemberle, W. H. Lotz, Richard Potts, C. W. Durham, L. P. Morehouse, Mrs. Morehouse, Geo. H. Frost, Miss. Hunt, R. J. McClure, W. F. Goodhue, G. C. Morgan, E. Powell, F. W. Clarke, J. E. Thomes, J. R. Willett. L. E. Cooley, Evanston, Ill.; Col. F. U. Farquhar, U. S. A., Mrs. Farquhar; W. L. Baker, Detroit, Mich.; H. P. Devock, Detroit, Mich.; J. L. Gillespie, St. Paul, Minn.; Max Hjortsberg, Chicago; M. Lane, Milwaukee, Wis.; Ch. MacRitchie, Milwaukee; Capt. O. E. Michælis, U. S. A., Mrs. Michælis; Alf. Noble, Detroit; W. S. Pope, Detroit; J. E. Sewell, St. Paul; J. R. Straughan, Ft. Wayne, Ind.; T. J. Nicholl, Springfield, Ill.; Mrs. Nicholl; R. P. Morgan, Jr., Springfield; Gen. W. S. Smith, Maywood, Ill.; Prof. E. N. R. Talcott, Morgan Park, Ill.; D. W. Wellman, St. Paul; J. F. Olney, Buffalo, N. Y.; W. H. Searles, Rochester, N. Y.; H. Seymour, Jr., Utica, N. Y.; C. H. Strong, Cleveland, Ohio; Mrs. E. P. Mason, Ann Arbor, Mich.; Miss. Mason, Ann Arbor, Mich.; R. Moore, St. Louis, Mo.; L. S. Olmstead, Jacksonville; L. M. Johnson, Keokuk, Ill.; B. F. Morse, Cleveland, Ohio.

REPORT ON THE KANSAS CITY WATER-WORKS.

Nos. 10 and 11, Vol. III, of the NEWS, for March 4 and 11, 1876, contain some account, with illustrations, of the Kansas City Water Works. We have therefore thought that the report on their condition, recently made by Col. Henry Flad and Thos. J. Whitman, of St. Louis, would prove interesting to our readers, and perhaps instructive. The engine-house, receiving cribs, settling basins, pump well and section of upper reservoir embankment, referred to in the following report, will be found in the drawings in the numbers of Vol. III above mentioned.

A pamphlet of the Holly Manufacturing Co. puts the daily capacity of the Kansas city works at 5,000,000 gallons; the length of pipe about 16 miles, all iron, 4 in. to 20 inches; in operation since Feb. 1875. fo supply about 40,000 people; duty of engine, with western coal, 50,000,000 lbs. raised 1 foot with 100 lbs. of coal; with anthracite or Pittsburgh coal, about 60,000,000; same class of engines have given on a close test 74,000,000 ft. lbs.; consumption of coal about 3 tons per day; highest elevation of hydrant above engines 230 ft., elevation of engines added, equal 264 ft. lift, and distance of same about 3 miles.

The report is as follows:—

ST. LOUIS, MO., *Dec. 23d, 1876.*

Hon. Turner A. Gill, Mayor Kansas City Mo.:

SIR.—Our examinations of the Water Works at Kansas City have been conducted with a view to enable us to form an opinion as to whether the works built by the "National Water Works Company" comply with certain conditions of the contract, and also as to the approximate cost and value of the works.

We divide the subject under five heads as follows:

1st. Does the quality of the water furnished comply with the requirements of the contract?

2d. Do the quality of materials furnished and the workmanship performed fulfill the demands of the contract?

3d. Can the tests called for by Sec. 8 of the contract be successfully performed by the works as now constructed?

4th. Approximate estimate of the cost and value of the works as now built?

5th. Estimate of the value of such parts of the work as in our opinion may be made available by the city.

The contract Sec. 1, provides that the "National Water Works Company, of New York," is authorized under certain conditions to "take, purify, store, conduct and distribute on and throughout the said City of Kansas, pure, well settled and wholesome water," and Sec. 14 the Company agrees and binds itself at "all times" to furnish a full and sufficient supply of "good, pure, well settled and healthful water * * * * such water to be suitable for domestic purposes."

The chemical analysis given in the report, purporting to be an analysis of the water from the Kansas river, and upon the result of which the location of the works seems to have been determined, is not, in our opinion, conclusive evidence as to the quality of the water furnished by these works.

In the first place there is no certainty that the water analyzed by Dr. Fay (see page 35 of report) was taken from the Kansas river. Dr. Fay has distinctly stated to us that he had no knowledge as to where the water was procured, that from his previous examination of the water purporting to come from the Kansas river he was exceedingly dubious in regard to these samples coming from the same source, and further, that the questions which were answered in his report dated May 16th, 1864, appear to him to have been framed rather for the purpose of getting favorable answers, than for the purpose of ascertaining all the facts in regard to the quality of the water.

In the examinations made by Whitman in 1872-73 for supplying water to Kansas City, the same Chemist (Dr. Fay) made the analysis and reported against the water taken from the Kansas river as being inferior to the water taken from the Missouri at Wyandotte.

As was stated in the report made in 1873, the samples of water analyzed by Dr. Fay (see page 34 of the report) were taken at a time when the water of the Kansas river was affected by back water from the Missouri, therefore the water of the Kansas river is probably even less fit for a city's supply than was indicated by these specimens.

And again, from other statements made to us by Dr. F., we consider it very doubtful whether the table on page 36 of the report refers to the water of the Kansas river, but rather believe that it is a comparison of the water of the Missouri river, taken at Kansas City with water taken from other sources.

From the best information we can procure on the subject we do not consider that the Water Company in taking water from the Kansas river have complied with the terms of their contract as regards the subject of quality, yet it would be necessary to have more positive evidence on this point, and we would therefore suggest to you that the best method to ascertain the facts of the case would be to have samples taken from the Kansas and Missouri rivers at least once a month, for a series of months and have a thorough analysis made of them by a competent and reliable chemist. In this way testimony could be procured on this point that would either confirm or set at rest the very prevalent belief that the water of the Kansas river is not fit for the supply of your city.

As to the character of the work done, it is our opinion that neither the spirit nor letter of the contract has been complied with in the quality of the materials and workmanship and in certain parts of its construction.

Sec. 4 of the contract (page 10 of the report) states that "if, upon examination, it be found that such works are not in all respects in good condition, and of first-class and sound materials then the city shall not be required to purchase the same at any time nor at any price;" also Sec. 17 of contract (page 20 of report) states "the said Water Works Company agree that their machinery and works shall be of the most durable material and first-class in all respects."

Our investigations lead us to the opinion that the "receiving cribs" at the river, the "receiving well," the "lower reservoir" or settling basin and the "upper" or distributing "reservoir" are temporary structures, that they do not fulfill the conditions of the contract, and are not, in any sense, to be considered permanent and reliable work.

The "receiving cribs" are constructed of pine timber and liable to decay in a short time. This timber work is exposed to the alternate action of air and water and under such circumstances cannot be expected to last long. The construction of the cribs as built would indicate that they were expected to answer the purpose for which they were designed but a short time.

The "receiving well," from the description given us, and as stated in the report, was made by sinking a wrought iron caisson, fourteen feet in diameter and eighteen feet high, until its lower edge was thirty-nine feet below the engine-room floor. After the wrought iron cylinder was brought to place, the earth was excavated one foot below it at the sides, and three feet in the centre and then the entire bottom covered with two and a half feet of concrete; after this, the earth outside at the top was excavated to a depth of about three feet and the space filled with concrete and masonry, and upon this masonry the engine foundations are built. This construction leaves about fourteen feet of the well protected from caving, only by the wrought iron cylinders; as soon as the iron rusts through, which must occur in a few years in such a position, the lower part of the well is liable to cave in, carrying with it the masonry and engine foundations. The likelihood is that this work will be rendered entirely useless, by the failure of the wrought iron in the caisson. In no case where reliable work is required does the mode of construction obtain, and a wrought iron caisson or cylinder of this kind, if used at all, is used only for a temporary purpose, the permanent work of either brick or stone masonry being carried up from the foundation on the inside of the cylinder.

The upper portion of the inside slopes of the embankment of settling basin seemed to be paved with a single course of brick laid on edge, without mortar. The concrete laid on the lower part of inside embankment slopes, appears poor and badly put on, and the stone masonry of a very inferior quality. We are unable to state the quality of the concrete laid over the bottom as it was covered with water, but presume it to be of the same class as we saw exposed. In fact the mason work of the entire basin is poor both in material and workmanship.

The embankments are but eight feet wide on top. This is a less width than is ever given to any work for impounding water, to the depth proposed here, except for temporary purposes. In regard to this basin, our judgment is that it would last but a short time, if it be made to perform the duty for which it was constructed, and the water line carried at an elevation, to secure the capacity mentioned on page 52 of report.

We consider the "distributing reservoir" on Tarbo's Hill, as even less reliable in its workmanship and materials than the settling basin. Here it is proposed to hold the water within high embankments, inadequately protected by a slope paving of poor material, laid in an inferior manner. This slope paving would offer but

slight impediment to the wash of the embankment provided the flow line was kept at or near its proper elevation. The embankments are but eight feet wide on top and should the water line be kept within two feet of top of bank (this is the elevation stated in the report as the high water line) the entire structure would probably soon be destroyed.

At the distributing reservoirs and also at the settling basin, the top of the embankments are plastered with a coat of cement mortar, about 1¼ to 2 inches thick. This would appear to be a useless expenditure. The plaster cannot possibly offer any resistance to the wash of the waves, nor for that matter can it be of use for any other purpose.

Sec. 17 further provides "and the reservoir or reservoirs from which the water shall be distributed shall in any case be on an elevation of at least one hundred and seventy-five feet above the city directrix of said city of Kansas, and the water therefore shall be distributed by the Holly system throughout the city."

A fair intepretation of the above would require that all the water to be supplied the city by their works should be first raised to the distributing reservoir, and from this point to be distributed throughout the city by the "Holly System." The plain intent and requirement of the contract, as set forth in the first part of, and in this extract from, Sec. 17 is, that two sets of pumping machinery were to be provided, one to be located at the source of supply, and the other to be located at the distributing reservoir.

This construction of the contract is borne out by the report of the engineer of the works who says, page 43 of report, "the first studies were directed to two pumping stations, one at the source of supply for filling the upper reservoir, the other at the upper reservoir for distribution." Following the above statement the engineer gives certain reasons for changing the construction of the works in this respect, and making such arrangement and disposition of the various parts as to result in a great saving in the running expenses of the department. It must be understood, however, that this result is obtained at a considerable sacrifice on the part of the city, for, had the original intent of the contract been carried out, two sets of pumping machinery would have been provided, located in different parts of the city and giving a very large, increased insurance against the danger of fires.

As now arranged, any break in the one engine leaves a major portion of the city without fire protection from these works. It must also be noted in this connection that the great advantage claimed for this departure from the contract is an advantage entirely on the side of the Water Company, as the city by the terms of the contract is required to pay a certain sum ($12,000.00) for the running expenses of the works, so that this change from the intent of the contract has been made to save the Company from any expenditure over this sum.

Without considering the question of which is the better of the two plans, it is plain that as built and arranged, the works do not answer the requirements of the contract as quoted above.

From the report (page 43) we also note that the supply of water for that part of the city called "lower town," is distributed from the reservoir in the ordinary manner, thus leaving this portion of the city depending entirely upon the pressure from the reservoir for its fire protection. This arrangement is also in conflict with the requirements of the contract as quoted from Sec. 17.

Another portion of the same section (page 21 of report) states that "the reservoir from which the water is distributed shall be of sufficient capacity to contain at one time at least ten days usual supply of water for said city and its inhabitants."

If we assume that at the time these works were completed the population of Kansas City amounted to thirty-five thousand and that the supply per capita should be not less than forty gallons (this is considerably less than is usually taken in a calculation of this kind), than to comply with the contract as to capacity and to be able to store a supply for ten days, the reservoir would be required to hold not less than 12,250,000 gallons.

Our measurement and calculations show that, with the flow line within two feet of the top of the embankment, the capacity of the reservoir is less than eight million gallons.

As before stated, our examinations lead us to the opinion that the construction of those parts of the work known as the "receiving cribs," the "receiving well" and the "upper" and "lower" reservoirs do not comply with the specifications; that they they are not first-class and of sound materials, and that, in this and other respects, they do not conform to the requirements of Sec. 17 of the contract.

The engine building, the engines and fixtures, and the pipe distribution may, we think, be considered as fairly complying with the contract as regards durability and permancy.

In regard to the ability of the works to perform the trial tests called for by Sec. 8 of the contract, we state that our calculations indicate that the test requiring the greatest capacity and strength in the various parts of the work is the second one mentioned, viz: (page 12 of report) "or eight streams as aforesaid through eight different hydrants in any part of the city, each throngh fifty feet of hose and an inch and a quarter nozzle to the height of one hundred and twenty-five feet."

We find that to perform this test, the pipe would be required to deliver about 3300 gallons of water per minute; the velocity, to furnish this amount, and the distance from the pumping stations, if the test be required at the points we indicate, would give a pressure of about lbs. to the square inch at the pumps.

If it be the desire of the city authorities to have the trial attempted, we would suggest the following places for the test, provided it is the wish to select to most difficult location, in order that one trial might answer for the entire city.

For the first trial we would take the fire hydrants located as follows:

No. 1—Independence Ave. and Holmes street; No. 2—Holmes street between Independence and Missouri Aves.; No. 3—Missouri Ave, and Holmes street; No. 4—Charlotte street and Missouri Ave.; No. 5—Charlotte and 5th streets; No. 6—Holmes and 5th streets No. 7—Cherry and 5th streets; No. 8—Locust and 5th streets.

For a second test we would select the seven hydrants located on Union avenue and one at the corner of Hickory and 10th streets. This second test is suggested in view of the statement given in the report (page 43) that the line of distribution pipe for "lower town" is only connected with the pumping main of the distributing reservoir, and that this section of the city depends for fire pressure upon the head of water due to this reservoir.

It is our opinion that the works are not constructed with sufficient strength and capacity and in such a manner as to successfully perform the trial tests as called for by section 8 of the contract.

We have made the following approximate estimate of the value of the works as now built. Our data for this estimate have been, from the nature of the case, very limited, while not claiming that the cost as here given is accurate, we believe the total to be a close approximation to the completed cost of the works. We consider the quantities and prices liberal, and in excess of rather than below the actual facts,

In making up the estimate of the pipe distribution we have used the quantities as furnished us by the City Engineer. The location and size of the pipes is shown on the accompanying map of the city. The fire hydrants we have located from the report of the Water Works Department.

Work and *material* of *receiving* cribs at river, completed		$3,500.00
Siphon Pipe,—furnishing and laying 1300 feet 24" pipe		9,750.00
Receiving Well—excavation, iron work and masonry of engine foundations and well completed		5,300.00
Engine building, boiler-house and chimney complete		15,500.00
Pumps, engines and machinery with valves and fixtures complete		50,000.00
Settling Basin, 1200 cu. yards earth excavation made into embankments, @ 40 cts.	$4,800	
350 cu. yds. stone masonry @ $6.50	2,275	
200 M Brick in slope paving @ $8.50	17,00	
1600 cu. yds. concrete @ $5.50	8,800	
Lumber, gravel and stone in filter complete	975	
Cement plaster on embankments	275,	19,350.00
Pumping Mains, furnishing and laying 6232 Lin. feet 20 inch pipe, complete		48,900.00
Distributing Reservoir, 20,000 cu. yds., excavation made into embankment @ 40 cts.	8,000	
2300 cu. yds. concrete @ 5.50	12,650	
1200 cu. yds. slope paving @ 1.50	1,800	
550 cu. yds. stone masonry @ 5.00	2,750	
100 feet tunnel @ 450	450	
Cross wall on tunnel and cement plaster on banks	3,90,	26,050.00
Pipe Distribution, furnishing and laying 2764 feet of 20-inch-pipe	18,434.48	
Furnishing and laying 956 feet 15".	2,350.92	
Furnishing and laying 18134 feet 12" pipe	62,859,32	
Furnishing and laying 10030 feet 10" pipe	278,23.06	
Furnishing and laying 18926 feet 8" pipe	39,789.76	
Furnishing and laying 17177 feet 6" pipe	25,971.24	
Furnishing and laying 1628 feet 4" pipe	1,790.80	
Furnishing and laying 1765 feet of 4" pipe not given by City Engineer	1,941.50	
Special castings, valves, fire plugs, 4" pipe for fire plugs, excavation through rock, etc.	21,500.00	
	$202,462.08	
	(say)	$202,500.00

RECAPITULATION.

Item 1. River work	$ 3,500.00
" 2. Siphon Pipe	9.750.00
" 3. Pump Well	5,300.00
" 4. Engine Building	15,500.00
" Engine and Machinery	50,000.00
" Settling Basin	19,350.00
" 7. Pumping Mains	48,921.00
" 8. Storage Reservoir	26,035.00
" 9. System of distribution	202,500.00
Total	$380.856.00

Add for real estate, engineering and contingencies, $14,144.00 giving approximate estimate as $395,000.00.

Should the city be satisfied with the quality of the water as supplied from the Kansas river, then in that case items Nos. 2, 4, 5, 7, and 9 may be considered as permanent and valuable work. The estimated cost of these items as given above amounts to (say) $350,000. In connection with this estimate, however, it must be remembered that the engine foundations are considered unreliable, from the fact that they are founded on the masonry laid around the well, which is liable to cave in by the failure of the wrought iron cylinder.

In case the present source of supply be abandoned then the only work that would be of real value and use to the city would be items Nos. 5 and 9, and in this case, the engines, etc., (Item No. 5) could not be valued at more than 50 per cent. of the estimate given above The two might be considered as worth about $233,000

THE BROOKFIELD TUNNEL.

Written for "Engineering News."

BY G. D. HERSEY, C. E.

In the following sketch it is proposed to give a somewhat detailed account of the purpose and construction of the Brookfield Coal Tunnel. It is located in Trumbull County, Ohio, and is a new opening to the coal mine called the Brookfield Slope,—one of the most extensive workings in the block coal regions of northeastern Ohio. The coal vein opened up by it lies in a range of hills forming the western boundary of the Shenango river valley, and at a depth of about 200 feet beneath the surface of their summit. The floor of the mine, like all others in this section, lies in undulations somewhat like a wrinkled carpet, varying in level from fifty to seventy-five feet. In the lowest and central portions of the seam the coal is from four to five feet thick, gradually thinning out to nothing on the upturned edges of the basin. The original opening was a slope, falling at the usual rate of one foot per yard. From the slope bottom radiate main and branch entries (with their hundreds of rooms) the aggregate length of which already is reckoned in miles. The slope was not put down on the lowest coal, hence the underground hauling has been uphill and expensive. The mine waters also drained *away* from the slope bottom necessitating special pumping machinery.

Heretofore the loaded mine cars, on being delivered at the top of the slope, were run along the brow of the hill for half a mile, thence down an inclined way, worked with wire ropes, also half a mile long, where the coal was dumped into railroad flats at the base of the

hill, and at a point not less than 130 feet below its original resting place. Thus the coal continued to be transported from the mine to the dumps by this cumbersome and expensive method, until the pumps and boilers became worn out, the incline got rotten and unsafe, and until the necessity of repairs, combined with the downfall in the price of coal, demanded a new opening and greater economy.

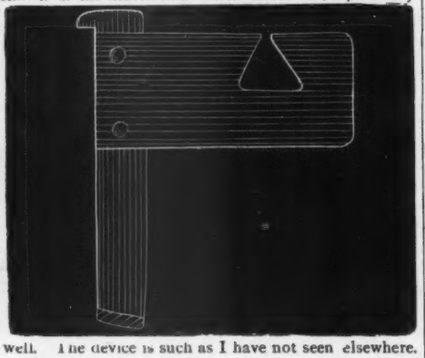
The great difference of level between the coal in the hill and the railroad in the valley, made it necessary to either cause the road to mount the hillside to reach the coal, or to carry the coal down to the road. There was no question, however, that the new opening should be a tunnel, and that it must furnish a natural drainage-way for the waters of the mine, as well as a route of exit for the coal itself. Accordingly in the location the first thing settled was to fix that point within the mine, which should be the inner terminus of the tunnel. As far as the present workings extend, that point was readily indicated by the flow of water in the mine drains. The inner terminus was then placed as far directly below this point as would bring it on a level with the bottom of the lowest coal (as shown by test drill holes) in those parts of the basin not yet developed. Having fixed one end of the tunnel, a preliminary survey showed the shortest route to day-light to be about 2800 feet, but the tunnel entrance would be high up on the hillside, at least a hundred feet above the railroads. Several schemes were advanced for overcoming this difference of level. It was proposed to extend the company's road from the place then occupied by the old chutes, and carry it up the hillside in switchbacks to the tunnel entrance. Another plan was to let the coal down from the tunnel mouth to the site of the chutes by an incline similar to the old one. A third scheme was a sort of compromise between the two preceding, and advocated raising the railroad tracks somewhat, carrying the loaded cars out from the mouth of the tunnel, at a slight descent, on a high trestlework, and dumping the coal down some sort of long chute, of which the design was never matured. For all of these projects were exposed to serious objections that ultimately destroyed them, along with several others of like character, and accordingly the "shortest tunnel" route was abandoned.

The plan finally adopted, and now carried into successful execution, is as follows: All the railroad tracks, weighing scales, etc., were allowed to remain unchanged by dumping the coal at the same spot as heretofore. Chutes as high as convenient to work (30 feet) were adopted, and a line of nearly uniform grade drawn from the top of the chutes to the inner end of the tunnel. Where this line struck the hillside was located the tunnel entrance. In round numbers it was 1,000 feet from the chutes and 4,000 feet from the inner end. The mouth is 72 feet lower than the inner end, the gradients being 1.71, 2.09 and 0.00 per hundred feet. In cross-section it is 8 feet at bottom, 6 feet at top, and 6 feet high in the clear, although in many places the rock has fallen, leaving the roof a pointed arch 8 or 10 feet high; 250 feet of the inner end is level and wide enough for two tracks, one being intended to hold the empty incoming cars, while trains of loaded ones are made up on the other.

The alignment of the tunnel is quite far from being straight, owing to several causes; some 400 feet of the inner portion lies partially in coal and partially in the underlying rock. As before noticed the floor of the mine is not level, and in this case a hill rose up sharply in the way, and it was thought best to drive around the point of it in order to take advantage of working in the soft coal, and avoid so much of the hard bottom rock. Secondly, three or four hundred feet more lay under the coal, with only a thin layer of rock between. Some old workings flooded with water lay in the way, and it was necessary for the line to avoid that; and, thirdly, the corner of lands not owned by the company lay across a direct line, which made another bend necessary. The final location being made accordingly, the center line, beginning at the mouth, runs thus: due west by a tangent 2,600 feet, thence deflects to the left, past corner of land spoken of, 37 degrees by a curve 390 feet in length, thence by a tangent, past flooded workings, of 620 feet, thence by a reverse curve around hill to the inner end.

Excepting a few feet at the mouth, the tunnel lies in rock the whole distance. About 130 yards at the inner end lies in a hard, light-colored sandstone, the remaining portion in a dark grey shale of varying toughness.

The work of removing the rock was begun at the outer face in June, 1875. When about one-third of the entire length had been driven, it was determined to hasten progress by driving from the inner end outwards. Consequently it became necessary to ascertain with great precision the direction in which to start the inner face. The only route by which a line could be run connecting the two faces was down the old slope and along the mine entries. Accordingly a traverse line was connected at the tunnel entrance with the center line of the portion already driven, and run thence up the steep rocky hillside for 1,400 feet, thence at nearly a right angle, a distance of 3,100 feet, to the top of the slope, thence down the same and along the main Dip and Scotch entries, by a very tortuous route, for 4,400 feet, to the inner face. Benchmarks consisting of iron plugs were inserted in the wall of the tunnel, and the the same route leveled from face to face. The part of the line lying in the mine entries was the most difficult to determine, with the requisite exactness, on account of its being broken up into such short sights and containing so many angles. The method adopted in running it was this: The stations were first marked and numbered on the roof, for the whole distance. In fixing them three mining lamps were used,—the rear one held at the station last fixed, and the other two so adjusted along the extremely crooked entry, that the distance between the two rear lamps was the greatest practicable, the station at the middle lamp marked, and the lamps moved on. Each station was placed precisely over a tie in the mine road, a hole drilled in the roof and filled with a wooden plug which carried an iron spud having a small vertical hole through a projection at its lower end. In the work of taking the angles a back sight and fore sight was used, similar to the one shown in the illustration, which served its purpose very



well. The device is such as I have not seen elsewhere. It consists of a square iron spike about eight inches long, headed and pointed. A piece of flat iron is riveted on to one side of it which has a three-cornered notch or aperture in it, with the upper corner open about one-eighth inch. Three such "sights" were employed. In using them a plumb-bob was hung to the spud in the roof and the sight hammered into the tie, so that the iron plate about bisected the angle at the station, and so that the open corner of the aperture was precisely under the point of the bob, which was then taken away and a mining lamp placed behind the sight, having the brightest part of its flame behind the open corner. The instrument being set up over the middle sight, with its plumb-bob where the first had been, the deflection angle was measured. The lamp flame was made large and bright and could be readily found through the glass, The open corner of the illuminated triangle was the point sighted at, but when the distance was so great that the cross hair more than covered it, still the line of sight could be easily adjusted with great accuracy by making the upper corner of the illuminated space on each side of the vertical hair appear at the same height. Each angle was read four times, and the average of the sum of the four readings taken for the truth. In turning the transit from back to foresight the telescope was revolved, but in turning from fore to back sight, the whole instrument was revolved on the lower spindle, thus eliminating, as far as possible, any instrumental defects. When an angle had been observed, the transit was set aside and the horizontal distance between the rear and middle sights measured with a steel tape to feet and hundredths. This done the back sight was taken up and fixed ahead for a new foresight, and the process repeated until all the angles and distances had been measured. Among the advantages derived from the use of these sights, it may be remarked that the transitman is not obliged to take anything on trust as to the correct position of the points he is looking at, and also when any given station becomes a back sight, precisely the same point is looked at as when it was a foresight.

These data being had, the alignment of the remain-portion of the tunnel was calculated, as also the proper angle to turn off from the inmost station in order to start the inner face in the right direction. The center line of the tunnel proper contains nine angles, and the traverse line thirty-four. Hence the accurate junction of the part of the tunnel driven from the inner face, with the part driven from the outer face, depended on a line containing forty-three angles in all, and nearly two and one-half miles in length. As the two faces were advanced into the rock, the center line was run forward by the same process as that described above. The permanent points fixed in the roof were kept back far enough from the face to be safe from the flying fragments produced by the shots, and temporary lines run forward to drive by. Finally, when the approaching faces broke through into each other, the center line was run together and the errors measured. The measured length of the tunnel was found to be shorter than the calculated length by one foot; the error in alignment was six inches. Below are given some of the principal features of this closed polygon:

Length of tunnel between terminal stations	4016.0
Number of feet driven from outer face	3193.0
" " " " inner "	823.0
Periphery of polygon closing at junction of faces	12997.6
Length of portion under ground	8438.0
Number of angles in polygon	43.0
Longest side of same	2735.6
Shortest side of same	40.0
Greatest inclination of any side	1 in 3
Extreme difference in el vation of any two stations	177.0
Amount of error in measurement at closing station	1.00
Amount of error in alignment	0.50
Amount of error in levels	0.30

On account of manner of driving tunnel, as described further on, no great accuracy in leveling it was called for, and they were made with transit in piecemeal as faces approached.

The ventilation of the outer portion was kept up by means of a furnace located at the bottom of a shaft sunk alongside the tunnel not far from its mouth. The short passage between the tunnel and furnace was closed by a partition and tight-fitting door (through which to supply the furnace with fuel). A wooden tube 16 x 20 inches in cross-section, made of four boards, had one end inserted in the partition. As the work advanced, the tube was extended along one side of the tunnel, its open front end being always kept within a few yards of the working face. Thus a ventilating current was drawn *in* through the tunnel against the working face, and *out* through the tube and up the shaft. The ventilation of the inner part was simply a branch of the general ventilating system of the mine and was kept up in the same way.

In the work of removing the rock, drilling was done by hand in the inside part, and by power drills run with compressed air in the outside part. Most of the portion driven by hand lay in sandstone. The manner of working as far as the coal reached, was to drive a heading in the coal, and blasting up the bottom rock in benches down to grade. After the tunnel went under the coal, the same process was continued except that for the last forty yards, the heading only was driven forward, in order to hole through, and thus the sooner finish pumping, as well as get better air. The part driven from the outer face lies wholly in shale, stratified horizontally, and having cracks or seams running through it (called "smooths" by the miners) every two or three feet in vertical distance. A heading, three to three and a half feet high, was started at the roof between two smooths, and were followed until they dipped a foot or so below grade, when the roof of the heading was broken through to another smooth, that followed in a similar manner, and so on. Three to five holes, four to five feet deep were bored in the face of the heading, charged with dualine and fired at once, the central holes leading by a few seconds. This method of working cleaned out the rock completely from floor to roof of the heading. The enlargement followed from four to five yards behind, the bottom being blasted up or the roof down as the case might be.

The crew engaged in removing rock at the outer face comprised, for twenty-four hours, 6 men in the heading, in shifts of 8 hours each, 4 men on the enlargement, in shifts of 10 hours each, and 2 men loading excavated rock into the mining cars, working 12 hours each. There were outside at the compressor, 2 engineers and also 1

blacksmith. The average rate of progress per day was 6.7 feet, making at the prices paid the men, the cost of *labor* only, for driving the tunnel full size, and putting the excavated material on to mining cars, very closely approximates $4.25 per foot. The material through which some parts of the tunnel extend, crumbled on exposure to the air, hence several hundred yards of it had to be timbered. In consequence of the work being done by the day instead of by contract, the data for estimating the exact expense is not at hand, but the entire cost of it as it stands completed ready for shipping coal is not far from $35.00 per yard

Twenty-one months is the total time employed in the execution of the work.

In conclusion it may be worth while to state, that with the exception of a bruised instep, by a fragment of rock falling upon it from a loaded car, the construction of the Brookfield tunnel has been completed without accident of any kind to any one in or about it.

EXPERIMENTS WITH BRICKS, STONE AND CEMENT.*

Translated by E. A. Rudiger, N. Y., for ENGINEERING NEWS.

The Royal School of Engineers, at Berlin, has been conducting a series of experiments on the strength of building materials, which has extended over a period of five years. The following are the principal results obtained by these experiments:

1. Bricks.

In the experiments, an entire brick was placed in the testing machine. The pressure per sq. inch was noted when the first crack occurred, and then the pressure which crushed the brick, the results of which are as follows:

a. Common bricks.

Number of sorts, 55. Number of tests, 843. Pressure at which first crack occurred—limits, 597–2672 lbs.; average, 1420. Crushing pressure—limits, 697–3200; average, 1765.

b. Hard burned bricks.

Number of sorts, 35. Number of tests, 850. Pressure at which first crack occurred—limits, 1114–3257 lbs.; average, 2175. Crushing pressure—limits, 1536–4395 lbs.; average, 2760.

The Department of Public Works of Berlin allows a pressure of 200 lbs. to the square inch to be taken where the best quality of brick and cement are used in building.

2. Natural Stones.

Six sorts of Diorite submitted to 43 tests; limits of strain at which first crack occurred, 8,178–19,100 lbs.; average, 12,415 lbs.; limits of crushing force, 8,820–21,820 lbs.; average, 13,755 lbs. Twelve sorts of Granite submitted to 133 tests; limits of strain at which first crack occurred, 3,300–14,365 lbs.; average, 9,785 lbs.; limits of crushing force, 4,437–15,575 lbs.; average, 10,200 lbs. Eight sorts of Grauwacke submitted to 30 tests; limits of strain at which first crack occurred, 9,100–12,160 lbs.; average, 10,113 lbs.; limits of crushing force, 9,743–13,725 lbs.; average, 11,065. Three sorts of Porphyry submitted to 45 tests; limits of strain at which first crack occurred, 5,050–6,160 lbs.; average 5,690 lbs.; limits of crushing force, 5,790–8,165 lbs.; average, 7,185 lbs. Seven sorts of Sandstone submitted to 125 tests; limits of strain at which first crack occurred, 870–7,282 lbs.; average, 3,985 lbs.; limits of crushing force, 1,189–9,815 lbs.; average, 4,780 lbs.

3. Cements.

There were also 3150 tests made with cements mixed in different proportions with sand. The following are the average results obtained in the tests of parallelopipeds 4" × 4" × 2¾" after hardening for 90 days. The strength was about the same whether the elements had hardened in the air or under water.

Pure cement—average strain at which first crack occurred, 4,125 lbs.; average crushing force, 4,708 lbs.. 1 part cement 1 part sand—average strain at which first crack occurred, 3,058 lbs.; average crushing force, 3,527 lbs. 1 part cement 2 parts sand—average strain at which first crack occurred, 2,375 lbs.; average crushing force, 2,773 lbs. 1 part cement 3 parts sand—average strain at which first crack occurred, 1,849 lbs.; average crushing force, 2,375 lbs.

Tests of mortar of the above proportions were also made to determine their resistance to a pull after hardening for 90 days, and it was found to be only about one-seventh of the resistance to crushing.

IMPREGNATED RAILROAD TIES.*

Experiments have been made on the government railroads of Hanover, and on the Cologne and Minden Railroad on the durability of impregnated railroad ties, and it was found, that of

Hemlock ties impregnated with chloride of zinc, 30 per cent. had been renewed after having been in use for 21 years.

Beechwood ties impregnated with creosote, 46 per cent. had been renewed after having been used for 22 years.

Oak ties which had not been impregnated at all, 49 per cent. had been renewed after 17 years' use.

Oak ties which had been impregnated with chloride of zinc, only 20.7 per cent. had been renewed after 17 years' use.

All the experiments were conducted under the most favorable conditions, viz., on good, pure and porous bedding.

Pieces of wood cut from impregnated ties in use at the expiration of the above periods, showed perfectly sound surfaces.

Observations made on the Northern Railroad of Austria (Kaiser Ferdinands-Nordbahn) have shown the following results:

Of oak ties which were impregnated, 74.48 per cent. had been renewed after 12 years of use.

Oak ties impregnated with chloride of zinc, 7.29 per ct. had been renewed after having been used for 7 years.

Oak ties impregnated with tar containing creosote, but 0.09 per cent. had been renewed after having been in use for 6 years.

Hemlock ties impregnated with chloride of zinc, 4.46 per cent. had been renewed at the end of 7 years.

Since 1869 the Northern Railroad of Austria use only oak ties which have been previously impregnated either with chloride of zinc or with tar containing creosote.

** Wochenschrift des Osterreichischen Ingenieur und Architekten-Vereines, Wien.*

TO PRINTERS.

Among the many useful inventions to the craft brought out of late, the Palmateer proof press ranks as one of the best. We have had one in use for some time and do not hesitate to recommend it. The bed is 13¾ by 36 inches, perfectly planed. The impression roller is adjustable by means of set screws, and a light or heavy

impression can be obtained. Proofs can be taken from type locked in chase, on galleys or tied up. It is a simple, strong, durable press, and cannot but be useful in any office, particularly in country offices that have jobs of small auction bills in small quantities: such jobs can be done very acceptably on this press when the other presses are occupied. They are made by the Mohawk & Hudson Manufacturing Co. of Waterford, N. Y., and are sold for $30, about half the price of an ordinary proof press. Another size, large enough to take a half medium Gordon chase, is made and sold at $40.

LUBRICATION.

BY. PROF. R. H. THURSTON.

(From the Polytechnic Review, March 3, 1877.)

When two surfaces are rubbed together, however smooth they may be, a resistance is met with which is called friction (from the Latin *frico*, to rub). When a current of fluid moves in contact with the surface of a solid or with a mass of other fluid, a frictional resistance is also produced. In the former case, this resistance is due to the interlocking of minute asperities of surfaces and their forcible removal. The smoother the surface, the smaller these asperities and the less the resistance. In the second case, the resistance is due to the production of little eddies and of currents within the mass of fluid. It is seldom due to real rubbing of fluid against solid. Fluid friction generally produces a much smaller resistance than the friction of solids.

The effect of friction is to produce abrasion and wear of solids and, with both solids and liquids, to effect a waste of the power which is expended in producing motion. In both cases, all power thus wasted passes away in the form of heat in the proportion of one British unit for each 772 foot-pounds of work; and the existence of this cause of waste is objectionable, not only because of the waste of power, but because the production of heat, in such considerable quantities that it cannot be disposed of promptly by conduction to the neighboring solids or by radiation into space, results in so great an elevation of temperature at the rubbing surfaces that inconvenience and, sometimes, danger may arise by the heating of the lubricant and abrasion of parts.

Lubrication is the means usually adopted to reduce losses of power and the evolution of heat. It consists in the interposition, between the surface of contact, of substances having a lower coefficient of friction than the rubbing parts.

The coefficient of friction is a figure which expresses the proportion which the resistance to the sliding bears to the force with which the two surfaces are pressed into contact. A very low value would be 1-20, or 0.05; a usual value is 1-10, or 0.10; a very high value is 1-4, or 0.25. In some cases, as where journals are "cutting," this figure becomes very high, and even so great that, in many cases, the pressure imposed would be insufficient to produce sliding. Journals are sometimes "seized," and fairly welded or soldered into their bearings. Solid surfaces, dry, give about 0.20 or 1-5th.

Since both resistance and the development of heat are to be prevented, a good lubricant should have the following characteristics: (1.) Sufficient "body" to keep the surfaces from contact under the maximum pressure; (2.) The least viscosity consistent with (1.); (3.) The lowest possible coefficient of friction; (4.) The largest capacity for receiving and carrying away heat; (5.) A high temperature of decomposition: (6.) It should vaporize at high temperatures, rather than decompose and burn on.

In some cases, friction-rolls or wheels are substituted for rubbing surfaces, and the resistance is then "rolling-friction," which is not properly friction at all.

Lubricants may be either solid or fluid; the former are to be used on journals carrying very heavy loads, and the latter under light loads. Thus, graphite is used in the former case, and the oils in the latter. Tallow is used for pressures too great to be sustained by the oils; and for extremely light work as in watches, the most limpid of oils is required.

The solid lubricants, in the order of their frequency of application, are: tallow, lard, soap, metallic compositions, sulphur, graphite, asbestos, soapstone, lampblack, carbonate of lead ("white-lead").

The metallic compositions and some special solid preparations, as Babbitt or anti-friction metal and metaline, are permantly fixed in the bearings as a lining; and their effect is to substitute, for the hard, rigid and resisting surface of the metal of the bearing, a material which more readily adapts itself to the form of the journal and which has a lower coefficient of friction together with sufficient conductivity for heat. Many solid compositions are used on the bearing by interposition.

Graphite should only be used in the state of an impalpable powder and should be free from acid. A mixture of tallow, graphite, beeswax, and white lead, all together, or two or more together with water, is used for the journals of car-axles on railroads. A mixture of palm oil, tallow and lime-water, or of cocoa or palm oil with water and caustic soda, is still better. Eight parts of wax of the bayberry, and one of graphite, is excellent.

The fluid lubricants usually employed are the cheaper and more common fixed oils. (A siccative, or drying, oil is unfit for lubrication). Sperm, whale, lard, neats-foot and tallow oils; glycerine; olive, rape-seed, cotton-seed and other vegetable oils, and the heavy shale and petroleum oils are most used. Water is often used, but its value is that of a conveyor of heat rather than a reducer of friction. For wooden bearings under water, it is the usual lubricant.

In the "Palier-glissant" of Girard, the journal is supported upon a cushion of water, the waste from which is supplied by a force pump. Among fluid lubricants, sperm and lard oils, heavy shale oil and crude heavy petroleum are most used for heavy journals. The latter oils are rapidly superceding the more expensive animal

oils. Mixtures of the two classes are much used. The mineral oils have a great advantage in their freedom from tendency to oxidize and "gum" after remaining a considerable time on the journal or exposed to the air.

The pressure which can be borne by a lubricant depends upon the character of the frictional surface, as well as upon that of the lubricant itself, and also upon the velocity of rubbing. The maximum for solid lubricants is unknown, but it is probably proportional to the value of the elastic limit for the material or for that of the metal of journal or bearing—whichever may have the lowest value. For steel surfaces, lubricated with the best sperm oil and moving slowly, 1200 pounds per sq. inch has been found admissable. Under the pivots of spring bridges, pressures of several thousand pounds per square inch have been used. For iron journals, 800 pounds should never be exceeded.

The following formulas were made, the first two by the writer and the last by Prof. Rankine, respectively, to determine the maximum allowable pressures when the speed of rubbing was known:

$$P = \frac{60{,}000\ l.\ d.}{V}(1.)\quad p = \frac{60{,}000}{V}(2.)\quad p = \frac{44{,}800}{V}(3);$$

in which P is the total maximum pressure on the bearing in pounds, l and d its length and diameter in inches; V is the velocity of rubbing in feet per minute, and p is the maximum allowable pressure in pounds per square inch of longitudinal section of the journal. The first two formulas were determined by experiment upon the journals of naval steam engines, the last by observing the performance of locomotives. The exposure of the latter to dust compels the adoption of large surfaces. In many cases, engineers give a length of journal equal to twice its diameter, and find that lubrication gives no trouble. A better practice is to calculate the proper length of journal from the special condition of the case, as by use of formula (1) thus;

$$l = \frac{PV}{60{,}000\ d.}(4.)$$

For line-shafting, journals are often made four diameters in length by the best builders.

Messrs. King, Stivers and Price, of the United States Navy, reported the following as pressures on the lubricants named at a speed of 200 feet per minute: best sperm oil, 75 lbs.; lard, 55; best mineral oil 65; highest 30. They gave the following as the temperatures of congelation:—

Oil.	Temp. of incipient Congelation.	Temp. of Solidification.
Summer Sperm Oil....	66° Fahr.	56° Fahr.
Winter " "	48 "	36 "
" Lard "	40 "	25 "
Best Mineral "	43 "	20 "
Very light "	18 "	Below 0 "

Lubricants as found in the markets are variable in value, as in cost; and neither buyer or seller can usually form an idea of their real relative or actual intrinsic values. The most expensive are often found by test to be the least valuable. The appended tables give the results of experiments made to determine the relative and the cash value of oils in the Mechanical Laboratory of the Department of Engineering of the Stevens Institute of Technology.

The testing machine is illustrated in the figure. It was designed by the writer to determine pressures and velocities permissible, and to ascertain the coefficient of friction, the rise in temperature and the endurance of the oils. This machine, as now built in the machine-shops of the Institute, was designed, in detail, by Mr. J. A. Henderson, M. E. Class 1873, now of the United States Naval Engineers, and was somewhat modified and constructed by the Class 1877 and for the market. It was exhibited at the Centennial Exhibition by the Stevens Institute of Technology.

A journal, F, is made on the overhung extremity of a shaft carried in the two bearings B B, and is given certain special dimensions. This journal is grasped by brass boxes which are carried in a depending piece, K. They are forced against the journal by a screw which compresses a coiled spring with a pressure which is read off on the scale, N N. A weight at the lower end of this arm, I, gives it the necessary resistance to deflection. The angle of deflection is measured on the arc O P, in such units that the division of the figures indicated by the pointer, at any given angle of deflection, by the figure indicated by the other pointer on N N gives the coefficient of friction. A thermometer, O, gives the rise of temperature as the bearing warms up.

A standard weight* of the lubricant to be tested is placed on the journal F, which is driven at the speed chosen by the experimenter, or at that at which the journals on which the lubricant is to be used, are run. The pressure is similarly adjusted and, the machine once started, the observer, with watch and pencil in hand, records at regular intervals the temperature, the coefficient of friction, the pressure and the speed of rubbing. As the bearing runs dry, the temperature rapidly rises and the experiment is concluded. The observer enters on his record the length of the trial, and makes a memorandum of the peculiarities of behavior which have been noted during the trial. In the Mechanical Laboratory of the Stevens Institute of Technology, several trials are usually made under different conditions.

Experiments upon the value of lubricants were made by Amontons, as early as 1699, and by many physicists and engineers since. Coulomb, Rennie and Morin are the most generally recognized authorities. The following are the values of the coefficient of friction, F, with different lubricants, according to Morin.

CO-EFFICIENT OF FRICTION:—MORIN.

MATERIAL.	F.
Wood on wood without lubrication	0.25 to 0.50
" " lubricated with soap	0.04 to 0.20
Metal on metal unlubricated	0.50 to 0.60
" " " greased	0.20 to 0.25
" " " wet with water	0.25 to 0.35
" " " oiled	0.15
" " " freely lubricated	0.05

The following table represents the results of experiments on the best known lubricants as obtained by the writer, by the method above described, using great care in selection and driving the rubbing surfaces at a mean speed of about 750 feet per minute. This speed is very high and is purposely chosen; otherwise, the trials under moderate pressures might occupy days. The table is valuable as representing the *mean* value of trials of nearly all the good oils in general use.

AVERAGE OF COMMERCIAL OILS:—THURSTON.

Pressure.	Endurance. Minutes.			Rise of Temperature.	Co-efficient of Friction.
Per sq. in.	Ave.	Min.	Max.		
8 lbs.	82	17	411	167° F.	0.20
16 "	29	9	97	212	0.16
32 "	10	2	19	228	0.12
48 "	8	1	13	228	0.10

The following are the results of trials of fair samples of well-known kinds of lubricants at a speed of rubbing surfaces of 750 feet per minute.

CO-EFFICIENTS OF FRICTION AND ENDURANCE OF LUBRICANTS:—THURSTON.

Name.	Pressure.	Endurance.	Rise of temperature.	Co-effieient.
Sperm (Winter) Oil	8 lbs.	111 Min.	230° F.	0.13
	16 "	29 "	225 "	0.10
	48 "	9 "	195 "	0.08
" (Summer) Oil	8 "	165 "	170 "	0.13
	16 "	33 "	215 "	0.11
	48 "	7 "	265 "	0.10
Lard Oil	8 "	77 "	175 "	0.16
	16 "	27 "	250 "	0.12
	48 "	11 "	260 "	0.07
Neat's Foot Oil	8 "	106 "	205 "	0.15
	16 "	31 "	275 "	0.10
	48 "	6 "	190 "	0.10
Olive Oil	8 "	83 "	170 "	0.13
	16 "	41 "	245 "	0.10
	48 "	14 "	240 "	0.06
Cotton Seed Oil	8 "	107 "	185 "	0.16
	16 "	45 "	275 "	0.12
	48 "	12 "	310 "	0.07
Palm Oil	8 "	49 "	195 "	0.17
	16 "	15 "	235 "	0.13
	48 "	9 "	295 "	0.07
Castor Oil	8 "	45 "	160 "	0.19
	16 "	35 "	180 "	0.11
	48 "	11 "	375 "	0.07
Fish (Cod) Oil	8 "	40 "	200 "	0.15
	16 "	14 "	175 "	0.12
	48 "	9 "	220 "	0.07
Crude Mineral Oil.	8 "	129 "	105 "	0.10
	16 "	97 "	285 "	0.10
	48 "	5 "	270 "	0.10

Many compound lubricants and commercial oils of unknown composition have also been tested and the results entered on the Laboratory Record and a very extensive list has been examined for the United States Government, the results of which, for obvious reasons, cannot, with propriety, be given here. The above table is amply sufficient for all practical purposes, and for such pressures.

To obtain the best results, oils of little body should be supplied to the bearing with the greatest possible regularity and with equal care, to avoid too great and too small a supply. The least that will be safe is best. Heavier oils should be supplied more freely, and tallow should be fed as fast as the journal will take it.

Stevens Institute of Technology.
Hoboken, N. J.

* This weight is just enough to thoroughly wet the bearing and journal.

ON THE PROBABLE ERRORS OF LEVELING; WITH RULES FOR THE TREATMENT OF ACCUMULATED ERRORS.*

BY WILFRED AIRY, B. A., M. INST. C. E.

(*Continued from page 92.*)

In the ordinary way of leveling, probably the man who took the check levels would follow in the same route as the man who took the original levels, and if so he would have found no error at all; but in leveling from one end to the other, and in reversing the operation and leveling back again, these extraordinary results were pointed out. He therefore could not help thinking the engineers who informed the Astronomer Royal of the possible error of 6 inches in 34 miles were not so far from the mark as they might be supposed to be.

MR. LAW remarked that one source of error, arising from the varying temperature of the atmosphere increasing or lessening the length of the bubble, had not been referred to. From the way in which ordinary level-tubes were ground, it was almost impossible to insure their being such a perfect circle that the results obtained should be equally accurate when there was a short bubble and a large one occupying a much longer segment. For this reason, some years ago, Mr. Ramsden applied to a transit instrument a circular level, similar to a watch glass, which, being ground as true as a lens, gave more accurate results,

MR. BINNIE said he was rather surprised that what he had found to be the most difficult error to estimate or to account for had been entirely omitted. If a person leveling, as he had done, in a tropical climate early in the morning, had occasion to level from east to west, or *vice versa*, he would find the staff brilliantly illuminated at one stage, but at the other in comparative shadow. The result was that the eye did not readily accommodate itself to the difference of illumination, and it was curious, in levelings taken in the morning and again in the evening over the same ground, to notice the differences that would arise, due, as he was convinced, to a great extent to the unequal illumination of the staves when placed in those extreme positions. He had a line of 10 to 12 miles, running east and west, carefully leveled with the best instruments by the best native observers, and was surprised at the errors taking place in that particular line. He tried it as an experiment on another arbitrary line running north and south, and the errors taken in the morning and evening, the usual time for leveling in India, almost disappeared. No doubt practised observers, eliminating their personal errors, would have reduced the error almost entirely, by varying the direction of the line with the illumination of the staff.

MR. REDMAN suggested that the greater error shown for the English levels might possibly arise from the small amount of time usually allowed for such operations in this country, and the rough-and-ready way in which they were generally carried out. Some few years back he took check levels with the late Mr. Augustus Hamilton Bampton for the permanent levels of the Plymouth and Tavistock railway. Mr. Bampton had an expensive, large, heavily-mounted instrument, while he used a small Simm's dumpy. On comparing notes the error between Plymouth and Tavistock amounted to 4 inches over 18 miles, which would give a value of 0.0185 foot per mile, corresponding very nearly with the third value set down for India in Table II. A series of levels had been taken in 1830 by Colonel Lloyd, R. E., whose levels were usually accepted as undoubted, and the benchmarks had been connected generally with the Ordnance Survey; the result then arrived at showed a difference of level between high water at London Bridge and Sheerness of 2 feet, whereas it was undoubtedly nearly 4 feet at that period as it was now. The discrepancy arose from the fact, that the levels were connected with a series of tidal observations that gave a higher range for the tide at Sheerness than was actually the case.

MR. R. H. HILL observed that there seemed to be a

possible error which had not been alluded to. Though certainly not a practical one for civil engineers generally, it might possibly come within the scope of an Astronomer Royal. In leveling from the equator to the pole, he imagined the line of sight was a tangent to an ellipsoid curve, and therefore that the offsets of that curve would not be equal. In leveling parallel to the equator the offsets would be strictly equal. What the amount of that error might be he was not in a position to calculate, but perhaps Mr. Airy, in his reply, would say if it was a calculable one in 400 or 500 miles, for instance of leveling; and if so, whether he had taken it into account in the results he had given.

Mr. ELWES said one source of error which might possibly throw some light on that accumulating error, was the fact that, in leveling operations, two observations were always taken from the same staff, and that there was a perceptible interval of time between the first and second. Now, the weight of a leveling staff was not altogether to be neglected, and it had occurred to him, that the weight of the staff pressing upon the point of support, espccially where a peg had not been driven in to carry the staff, might possibly lower its position, so that at the second reading it would be a trifling amount below what it was at the first. If ten observations were taken in a mile, and the error amounted only to 0.001 foot at each observation, it would give an accumulating error of 1 foot in 100 miles, which in the Irrigation Department in India, was considered the maximum difference to be allowed. This would equally apply, whether the fore staff was read first or the back staff, because in either case the second reading would be taken at an appreciable interval of time after the first reading, and in that interval, more particularly if the staff holder, in reversing the staff, lifted it up and let it fall, there might be a slight lowering of the point of support.

Mr. A. GILES remarked that his early days of leveling were connected with the old staff, when surveyors did not read their figures, but trusted to the staff-holder to move a vane up and down, and were dependent upon the accuracy of that man's movements for reading off the staff. He could not help feeling, as a practical leveler, that there were errors mentioned in the paper which no engineer in leveling for a canal, or waterworks or railway, would ever take into calculation. In the paper the maximum distance of the staff was put at 5 chains, and in India at 10 chains, but when accuracy to 0.001 foot was required the stations must be closer, since with an ordinary level the staff could not be read off to that nicety at 10 chains distance. If levels of such startling accuracy were required, the pickets must be firmly driven, nicely polished, and leveled off; they must be measured exactly equidistant from the level, and the engineer must never think of going out when there was the least breath of air to ruffle the instrument. There must also be plumb-bobs, and bubbles to keep the staff level. If an ordinary leveler were to be encumbered with these impediments he would never get through his work. He had frequently leveled 12 miles a day. He obliged his men to put stones down for pickets, and not trust to the picket being carried down ½ inch by the simple weight of the staff. In going up or down an incline it was true the back stations in going up would be farther off than the fore stations, and if the level was not perfectly in adjustment, there would be a slight local error at the top of the incline, but, by the same rule, in going down again that error would be corrected. He maintained that for all practical purposes an error of only 1 inch in 10, 20, or thirty miles was quite enough for any engineer to work to. No doubt, theoretically, it would be desirable to obtain absolute accuracy, but when he heard of a series of scientific levels having been taken between the Bristol Channel and the English Channel, which showed a difference of more than 1 foot, he should like to know on which line the error lay, and how it was corrected. No ordinary leveling by an instrument was exactly accurate, and the only course to prove its accuracy would be to take a series of levels from one side to the other and back again, and then to take the mean. He believed any practical leveler of the present day, with ordinary instruments, would be able to get much nearer than 1 foot of difference between the Thames and the Bristol Channel.

Mr. BARLOW said if he made use of the term "error," he should have said "difference." The matter was gone into with extreme care, and probably the mean of the two sets of measurements was more like the correct level.

Mr. J. N. SHOOLBRED stated with reference to the apparent discrepancies appearing sometimes in very careful leveling, a case which lately came under his notice in the neighborhood of Liverpool, where the levels had been conducted with the greatest precautions: he referred to the datum of the Ordnance levels for Great Britain, which had been fixed at Liverpool. There was also another of long standing in use there, called the "Old Dock Sill" datum. Though several well-known engineers had at different times leveled and compared the two systems, one would be surprised to find how much discrepancy there existed, amounting at least to between 3 and 4 inches, as to the actual difference of level between the two points of reference. This matter had been brought before the last meeting of the British Association at Bristol, and a committee, of which Sir William Thompson was chairman, was appointed to find out the real cause of the discrepancy.

Sir JOHN HAWKSHAW, Past-President, thought a little confusion had arisen in the discussion of this question; the point was not altogether what was sufficiently accurate for railways and ordinary engineering works. For a railway it could not signify much if in a length of 70 miles there was a difference of 1 foot in the levels. But there were operations where it did signify. For instance, the Ordnance levels were referred to the mean level of the sea, and to other standards which had to be ascertained; but if this mean level of the sea could not be ascertained with precision it might lead to considerable errors in some operations. With reference to the tides, although it was of importance to know what was the mean level of the sea round the coast of England, and in other and more distant places, he doubted whether it had yet been accurately ascertained. It was to purposes of that kind that papers similar to the present had an important bearing. Going from that portion, he might mention one or two things with regard to practical leveling. In the first place, he believed, if his memory did not mislead him, with regard to levels which he had to take a long time ago, he was able to get a little nearer than some of the differences referred to; but that was very much a matter of instruments. He had a large instrument made by Troughton with which he could read to 1-10 inch, at much more than 10 chains off; he believed to 1-10 inch nearly 1-4 mile off. He might mention a somewhat curious instance of comparison betwixt ordinary rough leveling and leveling with more scientific instruments. which occurred to himself when he had occasion to go to Saxony, now forty years ago, in order, in conjunction with Mr. Walker, to lay out the Leipsic and Dresdon railway. The then Astronomer Royal for Saxony had been engaged, before he commenced his operations, in making a section of the country. He had been three months in getting from Leipsic to Wurzen, about 14 miles; he used a large astronomical instrument, with which angles of depression and elevation were taken, and all the corrections that an astronomer could apply were made. When he got out to Saxony he was told that those operations were being carried out, but replied that it would be sadly too slow for his purpose, for he could not remain there above three months, the distance being about 70 miles. Starting, he ran over with a spirit-level from Leipsic to Wurzen in three days. They were only tried levels, but he wished to see the best line of country. He remembered quite well the difference betwixt the Astronomer Royal and himself was only 7 inches, showing that for common engineering purposes levels did not, perhaps, require to be taken with that minute care and accuracy which were certainly necessary for other operations.

Mr. ARTHUR WOODS said he had leveled several thousand miles in Australia. On one occasion, for the New South Wales Government, he had occasion to run a line of levels 300 miles, which was checked independently by the Victorian Government. In the 300 miles the difference was only 0.12 foot. He put in benchmarks every mile, and for any difference over 0.05 foot, used to go over the ground a second time. Iron tripods were used to rest the staves on, and he should have considered it very bad leveling to have had an error of 0.28 foot in 5 miles.

To be continued.

We understand the C. & T. R. R. dock, at Toledo. Ohio, was let at $55,000

CORRESPONDENCE.

PHILADELPHIA, *April 12, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—I should like to have the ideas of some of your correspondents, upon points in proportioning the sizes of a sewer for a main drainage receiving accessions at points on the line, necessitating an increased sectional area or velocity.

1. Where the velocity remains the same and greater sectional area required, should the increase in the vertical diameter of sewer be made at the top or bottom?

2. Where greater velocity allows of a decreased sectional area, should the vertical diameter of sewer be decreased accordingly; if decreased, should it be made at top or bottom?

3. Should the theoretical velocity be as nearly uniform as possible on the whole line; should it gradually increase towards its outlet; or may it vary at different points?

4. Should the maximum capacity of the sewer be calculated from the full sectional area;

The above to apply to sewers having ventilators and free at outlets. J.

MEXICO, MO, *April 14, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—In your issue of March 31st, I notice an extensive article from Mr. Morrison, evoked it seems by your editorial concerning a certain query as to the manner in which certain strains would pass under certain conditions that have already been stated. The query was put, as originally stated, for the purpose of provoking discussion, and I was just a little disappointed, when, receiving Prof. Greene's kind and explicit letter on the subject. I thought the object of my query had failed. Had the Professor's letter been published I shall always think it would have been quite beneficial to many of your young readers, and I presume, that realizing something of this, later, you wrote your editorial. If, as the "original querist," I should be allowed an assent to or dissent from the answers to my query, I would like to note some of the points in Mr. Morrison's letter—the greater part of which have already been predisposed of in your editorial.

The practical results reached by Mr. Morrison's mode of reasoning are the same as those deduced from considering the strains as passing through the web members, but to my mind, do not seem to be simple and so easy of application, especially in determining the position of the necessary counters. It was fortunate for Mr. M's showing of the 3d panel without diagonals that the relation of load and dead loads were such that there was no vertical or shearing stress in this panel and hence, under the circumstances, no diagonals necessary. Had 24,000 lbs. say, been substituted for the 7,200 lbs. counters would have been necessary in each panel, and *at least* a *portion* of the ⅙ would be seen straining each member. As to diagonal ties not being capable of transmitting tension, as set forth in proposition 6th, it is certainly admitted that they may be compressed to the extent of their tension, and after this any other tendency to distort their panel in that direction, must be received by a counter. For instance, a tie under 1,200 lbs. tension is just as capable of transmitting that amount of compression as the strongest iron column. With regard to its being a portion of bridge weight and not of the live load that is transmitted to the farther abutment, it is a mere matter of name. At any rate it is an additional amount of weight equal in this case to ⅙ of the live load and beginning in its effects at the 1st joint. If again we use 24,000 lbs. for 7,200 lbs., a portion of it *must* be considered as passing; for all the dead load of the bridge—placed at the farther abutment, is not sufficient.

Mr. Morrison's proposition 8 touches another subject, capable of being viewed in more than one light: "Two stresses cannot pass in opposite directions in the same panel at the same time." If a panel should have a single diagonal member (capable of bearing each kind of stress), subjected to say 1,000 lbs. tension, from one cause (say panel weight to the right of it) and 500 lbs. compression from another (say live weight to left of it), each considered separately may produce these respective effects beyond the point of meeting and yet leave the member in which they meet under a tension of only 500 lbs. They neutralize each other to the extent of the smaller, but *neutralized tension, philosophically speaking, is compression, and vice versa.* Any one in the habit of analyzing the Warren or triangular girder, will recall how convenient it is to consider strains of different kinds as passing each other in a certain member and performing effects beyond the point of meeting. When each stress on said member, due to every weight is considered, the algebraic sum (calling one kind plus and the other minus), will give the kind and amount of that kind of strain that the member is under for those conditions. The member is left under only one kind of strain, but that *strain alone* furnishes no clue to the amount, kind, or direction of the strains of which it is the resultant. Very respectfully,

J. N. BASKETT.

P. S.—Your editorial concerning a text-book on Engineering is on the right subject. I have searched for such a book but cannot find any to suit. A review of all previous mathematics is necessary with most of our treatises. J. N. B.

ARCHES;

CONSIDERED GRAPHICALLY.

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(*Continued from page 82.*)

46. For any position of the weight plot the value of y_0 and draw the curve of equilibrium. Then draw the two lines from the extremeties of the load line W, parallel to the sides of the curve, and thus determine H and the two vertical components of the reactions, which vertical components will be the same as for a beam supported at its ends. But, from the simple relations of the similar triangles A G C and 031, as also B G C and 032, we may write a general expression for H, if desired. Thus we have

$$y_0 : c - b = P_2 : H, \text{ or } P_2 = \frac{y_0}{c-b} H;$$

$$y_0 : c + b = W - P_2 : H, \text{ or } W - P_2 = \frac{y_0}{c+b} H.$$

Eliminating P_2 in the second equation by substituting its value from the first, we get

$$W - \frac{y_0}{c-b} H = \frac{y_0}{c+b} H, \text{ or } W (c^2 - b^2) = 2 c y_0 H;$$

$$H = \frac{c^2 - b^2}{2 c y_0} W = \frac{1 - n^2}{2} \cdot \frac{5 (5 - n^2)}{32} \cdot \frac{c}{k} W. \qquad (12.)$$

This value also will apply to a load on either side of the center.

It will be observed that, to obtain this value of H, we have simply to divide $\frac{1-n^2}{2}$ by the factor which multiplies k in (11.), and thus get the factor by which $\frac{c}{k}W$ is multiplied. The numerical values of this factor are worth obtaining, as, the computations once made, the results apply to every rib with pivoted ends. Let the span of the arch be divided into any convenient number of equal parts, and, for illustration, suppose that the number is ten, as shown in the figure; let a weight W be placed successively over each point of division, being supported by the rib. The calculation may conveniently proceed in the following manner:—

Find the different values of y_0, for different positions of W, by equation [11′.]. Then compute H by [12.] The calculation and results are given below; the curves of equilibrium and values of H are represented in Fig. 10, for one half of the arch. As n^2 is positive, whether n is + or −, the values of y_0 and H will be symmetrical on each side of the center.

VALUES OF y_0 AND H.

$n = \frac{b}{c} =$	0	.2	.4	.6	.8	
$5 - n^2 =$	5.00	4.96	4.84	4.64	4.36	
$5(5 - n^2) =$	25.00	24.80	24.20	23.20	21.80	
$\frac{32}{5(5-n^2)} =$	1.280	1.2903	1.3223	1.3793	1.4679	k

Multiply these factors by k to give y_0.

$\frac{1-n^2}{2} =$	0.50	0.48	0.42	0.32	0.18	
$\frac{1-n^2}{2} + \frac{32}{5(5-n^2)} =$	0.3906	0.3720	0.3176	0.2320	0.1226	$\frac{c}{k}$ W

Multiply these factors by $\frac{c}{k}$ W to give H.

For any other desired division of the span another such table is easily computed.

47. If every point of division were loaded with W at the same time, the value of the horizontal thrust would be equal to the sum of the H's for each load, that is, the factor in column 0 plus twice each of the others, and the sum multiplied by $\frac{c}{k}$ W; we thus obtain $2.479 \frac{c}{k} W = H$. If a *truss* were uniformly loaded horizontally, the bending moment at the middle would be one-eighth of the total load multiplied by the span, or, for a truss of ten panels, with W = one panel load,

$$M = \frac{10 W \cdot 2 c}{8} = 2\tfrac{1}{2} c W;$$

and the tension in the lower chord, or the compression in the upper chord, would be found by dividing this quantity by the height of the truss, K. If the span of the arch just treated had been divided into twenty equal parts, the value of H, for loads at all the points of division, would have been $4.990 \frac{c}{k} W$. The truss, as before, would give $\frac{20 W \cdot 2 c}{8} = 5 c W$.

We thus see that the funicular polygon, for a number of equal loads, equidistant horizontally, on a parabolic rib, gives a value of H approximating closely to that for a uniform load on a truss of height k, coming nearer as the loads increase in number, and agreeing when the load is continuous, when the funicular polygon will coincide perfectly with the parabolic rib and give the same horizontal thrust as we are accustomed to in the bowstring girder under a maximum load.

48. We may now, if we please, compute values of the bending moment M for numerous points, when W is placed on any one point. If y denotes the ordinate from A B to the inclined line, and z the ordinate of the parabola from any point D, the bending moment may be written

$$M = H [y - z]. \qquad [13.]$$

If put in this form, it will be seen that, in the neighborhood of y_0, M will be positive. As the arch has a tendency to move away

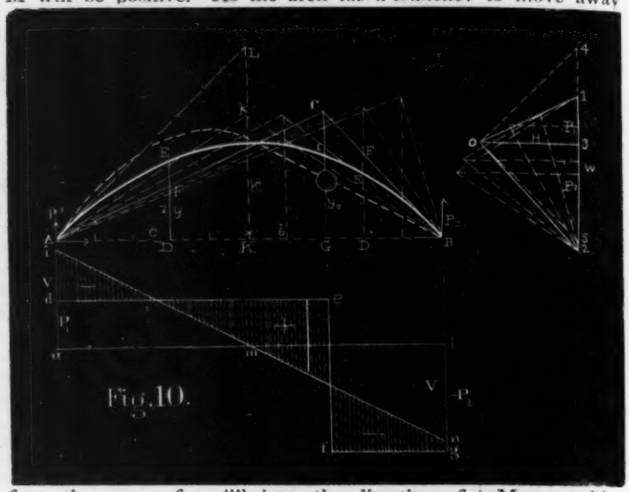


Fig. 10.

from the curve of equilibrium, the direction of + M, or positive bending, will coincide with that for a beam supported at its two ends, tending to make the arch flatter, and, so far as bending is concerned, causing compression on the upper side and tension on the lower side of the rib. As this is the most familiar flexure of a beam or truss we have chosen to consider it as positive. When the curve of equilibrium runs inside of the centre line of the arch, — M will produce the opposite effect.

The ordinates y and z can be readily calculated from the figure. Thus, if the weight is at 4-10 c from the middle of the span, we have found y_0 to be 1.3223 k. If the span is divided into ten parts, the number of divisions on one side of the weight being seven, y will be successively 1-7, 2-7, 3-7, etc., of y_0; on the other side y will be 1-3 and 2-3 of y_0. The sum of the denominators always equals the number of divisions, and the fractions run from both ends up to unity. After finding the first y at each end, simple addition obtains the others, and the row is checked by obtaining y_0 at the proper point. As stated in § 45, the ordinate z is proportional to the product of the segments into which it divides the span, or, if it is at a distance nc from the middle, we have

$$z = (1 + n) c (1 - n) c \cdot \frac{k}{c^2} = (1 - n^2) k.$$

The factors by which k is to be multiplied can therefore be at once obtained by taking the *decimals* which are found in the second line of the table for y_0, § 46.

49. The computations may then be set down in the following shape, viz.:—

VALUES OF M. y_0

Point of Division.	1	2	3	4	5	6	7	8	9	
$\frac{y_0}{7} =$	.1889	.3778	.5667	.7556	.9445	1.1334	1.3223	.8815	.4488	$= \frac{y_0}{3}$
$z =$	.36	.64	.84	.96	1.00	.96	.84	.64	.36	
$y - z =$	−.1711	−.2622	−.2733	−.2044	−.0555	+.1734	+.4823	+.2415	+.0808	k

Multiply through by $H = 0.3176 \frac{c}{k} W$.

	−.0543	−.0833	−.0868	−.0649	−.0176	+.0551	+.1532	+.0767	+.0257	c W

Multiply these factors by c W to give M.

With the explanation already given, this table can be readily understood. The letter y_0 is placed over 7 as a convenience, to show that the value y_0 occurs at this point of division. If the load is on the right of the center, these numbers run from the left abutment; if the load is on the left of the center, they must be considered to run from the right abutment. It is worthy of notice that, while the value of y_0 is independent of the span of the arch, M is independent of the height of the arch.

(*To be continued.*)

COUNTRY HIGHWAYS.

One of our correspondents has expressed the desire that we might find time to write something about common roads. There are in our last volume several articles, contributed and selected, which bear directly upon this subject, but, as this volume is out of print it will be of little use to refer our numerous new subscribers to its pages. The book of Gen. Gillmore's, published not many months ago, contains very much useful information in this direction, and we have also meditated spreading upon our pages one or two excellent essays which are not now readily accessible.

This is the time of year when the usual spring repairs are made upon the highways which, as the frost comes out of the ground, make very plain to the traveling public where their weak points are. They are put in such a shape as to look easonably well for the present, and during the dry time of summer, all the money which is appropriated for such purposes is expended at once, and they are then left to take care of themselves until another town-meeting, in the next spring, appoints a new overseer of highways and places some means at his disposal. There are some points in regard to our usual methods of making and renewing roads to which attention cannot be too often called, and we shall be glad to aid in some slight degree the adoption of a better practice.

In making a new road it is very poor economy to leave the natural surface soil or vegetable loam in place, covering it perhaps with a layer of good gravel. The loam is moderately retentive of water, will work up through the gravel and form mud or dust, in a wet or dry time. Water is at the bottom of about all the trouble with a road. If the foundation is well drained, and the surface is so consolidated that rain will run off before it has time to soak in, we shall have a good roadway in all weathers. One great object of the layer of large stones which forms the bottoming or foundation course of a Telford road, the very best highway possible without pavement, is to permit the thorough draining away of all water. Another object is to distribute the pressure, which is concentrated by the wheels of a loaded wagon on a very small spot at the surface, over so large an area at the base that ruts and hollows shall not be formed. Ruts retain rain-water which must necessarily soak into the surface, softening it and allowing the wheels to cut still deeper through what ought to be a hard crust.

If stone for under draining cannot be procured, small drains at frequent intervals across the road ought to be introduced, built of such materials as are reasonably cheap and accessible. A considerable sum of money, judiciously laid out on first construction, is a good permanent investment, for it can be made to produce a *permanent way* worthy of the name. The saving in annual repairs will warrant the capital outlay. Of course it is desirable that the road should be raised somewhat above the surrounding level to secure drainage, but if this is only accomplished by digging ditches at each side, the material from which makes the road, while these ditches have no outlet but stand full of water during the winter and spring months, these trenches are of no use; for the water is naturally at the same level below the road as in the ditches, or even higher from the absorbing power of the earth, and the material is such that it readily poaches up and wheels go in to their hubs. Then the neighboring fences are called upon for contributions, till sometimes the mudholes are almost corduroyed with rails. By the way, corduroy does not make so bad and rough a road, if the covering material is up out of the way of the water, and will bind enough not to cut through.

The ordinary plan of allowing the working out of taxes on the highway, pretty much as the notion takes each one, under no, or very little, skilled supervision, is an excellent example of "how not to do it." The plow and scraper are all the tools needed. The sides of the road are broken up with the plow, the soil, sods, and washings from the road, consisting of old soil previously taken from the ditches, materials ground to dust under the traffic, droppings, etc., are scraped from the sides to the middle, well rounded up to let the water run off, and left to be consolidated by the wayfaring public. Nobody, after a moment's reflection, would expect such a road-bed to keep in shape or carry heavy weights. A mistake is made in giving so much convexity, as is often the case, to highways. The traffic is driven to the middle of the road, so that the wear is concentrated in a narrow track, and ruts are speedily formed, in place of being distributed over the whole of a gently sloping surface. That country roads are patched up and left in this shape is probably due to the fact that ordinary supervisors give little thought and study to the matter, but follow implicitly the bad precedents of their fathers.

Broken stone makes an excellent and durable surface when once consolidated, although the process of consolidation is hard on vehicles when the public have to do it. Road-rolling can only be expected in large towns. Sprinkling and a slight dressing of gravel hastens and assists the binding. MacAdam did not advocate any preparation of a foundation, but Telford believed in making a dry and durable substratum of stone; the road by the latter method is much the better. It is wrong to add gravel or broken stone to a road surface without first removing the mud and refuse; this mud works among the stones and prevents their binding. Broken limestone and sandstone are not so good for a coating of roads as is a harder material, for they wear round under the wheels and the pulverized portion makes mud and dust, hindering also the binding as before. Granite and Trap make good broken stone. The softer stones, however, do well for the foundation course.

It would be an excellent thing for our roads if broader tires for heavily loaded wagons should come into use; the wear of the road would be much decreased and, while the tractive power required would not be increased but rather diminished, on pavements, it would be very much lessened on country roads. Good roads are a direct benefit to all who use horses, a credit to any town, and an indirect benefit to everybody.

If any of our readers who have had experience in making highways can inform us whether it is possible to make a good, durable road, in alluvial soils, such as prairie earth, where stone and gravel are not to be had, and how it is to be done, they will confer a favor on many of the subscribers to this paper.

We have sketched, rather briefly, a few of the points which have occurred to us as worthy of notice in this connection, and shall be glad to hear from those who have had experience, and can give us facts, items of cost, and statements of success.

ERRATA.

In our article on "Strength of Columns," in the last number of the NEWS, 1st column, 29th line, for *number supplying* read *numbers applying;* 21st line from bottom, for *and* read *in;* 14th line from bottom, for *regular* read *rectangular;* 2d column, 17th line, omit the first sign of equality, leaving the expression $n f' b h^2 = M$; 31st line, for *as long so* read *so long as.*

As the communications from the associate editor cannot be revised by him, he is obliged to depend upon others for the correctness of the proofs, and we regret that these errors escaped the eye of the proof-reader.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

Owing to the absence of so many members in attendance at the Convention of the American Society in New Orleans, and particularly on account of the absence of the Committee on the adoption of the Metric System, who were to report at the May meeting, there will be no meeting of the Civil Engineers' Club of the Northwest in the month of May.

L. P. MOREHOUSE, *Sec.*

CO-ORDINATE SURVEYING.*

BY HENRY F. WALLING, C. E.

RELATION OF SURVEYING TO GEODESY.

Surveying is commonly defined as the art of measuring, laying out and dividing land. The similar but more comprehensive art of geodesy applies to the earth itself, as indicated by the etymology of the word, which is derived from *γη. the earth* and *δαιω, I divide.* Its objects are, the determination of the form and dimensions of the earth and of its different portions; the continents and islands with the lakes, rivers, mountains, civil divisions, etc. Its processes, like those of astronomy, upon which, indeed, it is to a considerable extent dependent, require instruments of a high degree of precision and mathematical computations of great refinement.

* From the Transactions of the American Society of Civil Engineers.

GENERAL GEODETIC CO-ORDINATE SYSTEM.

In the operations of the great geodetic surveys of the world, including for our own country those of the United States Coast Survey, positions are finally determined by referring them to co-ordinate planes. The plane of the earth's equator forms one of these co-ordinate planes and that of an assumed standard meridian another, the origin being the center of the earth or the point where the earth's axis cuts the equatorial plane. The position of any geodetical point is fixed by determining the direction in space of its radius vector, as referred to the two co-ordinate planes, and the length of this radius vector. Its angle with the equatorial plane measured on either side is the latitude; the angle of its projection upon the equatorial plane with the meridional plane, measured in either direction around a semi-circle is the longitude, and the length of the radius vector, or rather its excess over that at the level of the sea is the altitude of the place determined.

VARIATION BETWEEN OBSERVED AND TRUE LATITUDES.

Owing however to the spheroidal form of the earth, latitudes as observed and recorded do not exactly represent the co-ordinate angles or true latitudes. The observed latitude of a place is the angle made by a normal to the earth's surface at that point with the equatorial plane. The co-ordinate angle could easily be computed from the observed latitude if the earth were an ellipsoid of revolution of known eccentricity.

IRREGULAR FORM OF THE EARTH.

But it has been found that this is not the true form of the earth. The equator, and probably all parallels of latitude, taken at the level of the sea, vary more or less from true circles, indicating a want of homogeneity in the materials which make up the earth's volume. Longitudes are measured by noting the earth's rotation angles on the undoubted assumption that its angular velocity is strictly uniform. By noting the difference in time between the passage of a normal to the earth's surface at any particular point, and of another normal at any point on the standard meridian, across a celestial meridian, we obtain an angle which is called the longitude of the former point, the longitude of the standard meridian being zero. Irregularities in the form of the earth of course change the direction of normals to its surface, and require, both for latitude and longitude determinations, corresponding corrections.

ITS DETERMINATION A DIFFICULT PROBLEM.

In consequence of these irregularities, the problem of determining the exact form of the earth is an exceedingly difficult one. Instruments of the highest degree of precision must be used by skilled observers, and the combined results of a vast number of careful observations over widely extended areas must be subjected to the most refined mathematical investigation before its full solution can even be approximately obtained.

PROGRESS MADE IN ITS SOLUTION.

Its investigation has been going on however for one or two centuries; and very fair progress has been made. The great national surveys of the world have been conducted by men eminently qualified for the task, and the results of these surveys so far as completed, seem to approach quite near to the attainable limits of accuracy.

UNITED STATES COAST SURVEY.

This is particularly the case with our own Coast Survey which is probably unsurpassed, if not unequalled in precision and general accuracy. Our country, however, has thus far failed to realize some very important advantages which might be derived from these Coast Survey operations, although they have been sufficiently carried out to render them available over considerable portions of the country.

OBJECT OF THIS ESSAY.

It is the object of this paper to point out a simple method by which the high degree of precision which accompanies the Coast Survey work may be made available in the ordinary operations of land surveyors and civil engineers in those districts over which the Coast Survey triangulations have been carried, and at the same time to call attention to the importance of an extension

of these triangulations over the entire country, either by the general or by State governments. One of the disadvantages of our peculiar confederate form of popular government is an apparent inability of disposition to undertake works of acknowledged and eminent utility, unless they are popular with the masses or with those who control the machinery of elections. It is certainly the experience of foreign countries, including several less wealthy and prosperous than our own, that these surveys are many times more valuable than their cost, in the aid they afford to the carrying out of internal improvements, to the equalization of taxes and to many of the necessary operations of general and municipal governments, as well as of private individuals. But in this country where legislation usually follows, instead of leading, the expresssion of general public opinion, such works are likely to await the slow and gradual cultivation of the popular mind to a proper appreciation of their great utility.

CONGRESSIONAL LEGISLATION

In the meantime, it must be admitted that Congress has enacted a very liberal and wise law by which the Coast Survey is authorized to extend its triangulations over any State in which scientific surveys have been provided for by the State Legislature. Moreover the Superintendent of the Coast Survey evinces a disposition to construe this act with great liberality. It is understood that he will, where thorough topographical surveys are undertaken by State authority, cause the subsidiary triangulation to be carried to any reasonable degree of minuteness with the same refined accuracy which has characterized the work already done by the officers of the survey. Indeed, with their elaborate determination of local irregularities in the form of the earth, and their well organized corps of skilled observers and computers, they have an immense advantage, which could hardly be soon obtained by any new organization, for extending the triangulation over whole States and carrying it to the secondary and tertiary stages.

TRIANGULATION OF MASSACHUSETTS.

The State of Massachusetts is entitled to the credit of being the first of the United States to recognize the importance of having her territory carefully surveyed and to commence upon such a work. More than forty years ago, a triangulation was commenced which was completed in 1842. This triangulation will compare favorably with the Coast Survey work and with the other geodetic surveys of the world. But a surprising indifference to its value, or potential utility, seems to have prevailed, and up to the present time, no further use has been made of it than to adopt it for the basis of such State and county maps as have from time to time been published. These maps give only the horizontal locations of objects obtained from such imperfect surveys as could be paid for by the sale of maps, published entirely by private enterprise, no assistance being given by the State.

STATE SCIENTIFIC SURVEYS.

At the present time, the subject of scientific surveys is being agitated in the States of Massachusetts, Rhode Island, Connecticut and New York. The latter State appropriated $20,000 in 1876 for preliminary organization, to effect which it appointed a skilled director. The other States mentioned have organized commissions to investigate and report on the subject.

REFORM NEEDED IN LAND SURVEYING.

Before proceeding to describe the proposed combina- of surveying with geodesy, a brief consideration may be permitted of the urgent need of reform in the prevalent methods of land surveying and of writing descriptions in conveyances of land, based, as many of these descriptions necessarily are, upon imperfect surveys, and frequently upon no surveys at all. Lawyers and land surveyors are perhaps more familiar with the short-comings of these conveyances in failing properly to describe the property conveyed. A large share of litigation of the country arises from this cause. Indeed the laxity in this respect is something almost incredible. Scarcely one deed of conveyance in a hundred, will be found to contain such a description of the land conveyed as would fix its location with certainty, if the fences, walls or other inclosures should become obliterated, a contingency which is quite likely to arise.

CONFLAGRATION OF DETROIT.

An occurrence of this kind on a rather extensive scale took place in 1805, when the city of Detroit was devastated by fire, and so thoroughly destroyed, that it was found quite impossible to ascertain the former boundaries of estates. Their restoration was entrusted to the Governor of the State and a council of judges, who could find no better way out of the difficulty than by relaying out the city on an entirely new plan, dividing the lots among the former owners as equitably as possible.

Notwithstanding this experience, the lines of streets and lots in Detroit are now so uncertain that disputes and litigation in regard to them are of continual occurrence. The same is true in most of the cities and large towns of the United States, especially in surburban districts and growing villages where land is rapidly increasing in value.

FAULTY DESCRIPTIONS IN LAND CONVEYANCES.

If we examine the descriptions given in land conveyances, we shall find that they usually fail to fix either the location of the property by reference to permanent land marks, or even the position of its boundary lines relative to each other. Frequently the tract conveyed will be bounded in the deed by the several tracts adjoining, of which the only description given is to state the names of the supposed owners. In many deeds, all dimensions are omitted and only an indefinite approximation to the quantity of land conveyed is given, the statement being that it contains about so many acres, "be the same more or less." Where good permanent division fences, walls, hedges, ditches, streams shore lines, bound-stones, stakes, etc., mark the boundaries, and are properly described, such descriptions may answer the purpose so long as the boundaries remain unchanged, although such indefiniteness as to quantity would hardly be tolerated in the sale of other kinds of property.

OBLITERATION OF MONUMENTS.

But physical monuments are continually becoming obliterated even when well defined at first. It is said to be an old custom in some parts of the country, to take children once in every year to important boundary corners, where monuments have been erected, to the location and surroundings of which the careful attention of the children is directed. If on a subsequent visit, their memory is found to be at fault, it is refreshed and deepened by combining with it that of a sound flogging.

UNRELIABILITY OF SURVEYS.

Even where surveys have been made, they are in many cases so unreliable that the recollections of old residents in the vicinity, considerately stimulated, perhaps in their youth in the way described, are more reliable in determining the proper location of lost boundaries, than the retracing of old surveys. This is not surprising when the modes of surveying and the character of the instruments used are taken into consideration.

To be continued.

PUMPING ENGINES.*

BY JOHN BIRKINBINE, OF PHILADELPHIA.

In all metallurgical processes and mining operations, water is an element which receives attention from the management; and provision is required either for a means of supply, or for the disposal of accumulation. In many works the quantity of water to be furnished is sufficiently large to place the item of water supply of equal importance to the reception of material or disposition of product; and the means to be employed receive, or should receive, the most careful investigation.

There are exceptional cases where mines or quarries possess a natural drainage, but a large majority of the useful ores and the fuels delved from the earth are obtained from workings in which water accumulates and must be removed. Often the quantity to be disposed of is very great, and the distance to which it must be elevated amounts to hundreds of feet.

The magnitude of the work to be done, either in furnishing a supply for large metallurgical works or in draining extensive mines, demands the employment of powerful machinery, the economical operation of which is of great importance to the management, both as a pecuniary and practical consideration. It is therefore probable that a few notes on the general character of pumping engines may prove interesting to many of the members of the Institute. No attempt will be made in this paper to go into details of special machines, but the general features of the different classes will be briefly considered.

When a large amount of water is to be elevated to any considerable height, the prominent question to be considered is not "what will sufficiently powerful machinery cost?" but it is, "what will be cost per annum, or per ton of product, to drain the mine, or supply the works?" as the case may be.

To obtain this information it is necessary to be in possession of the following facts:

1. Fuel consumed to do a given amount of work.
2. Durability, and liability to derangement, breakage or repairs.
3. Cost of attendants, lubricants, etc.
4. Interest on first cost of machinery.

The items rank in importance in the order named.

The term "duty," as applied to pumping engines, indicating how many million pounds of water can be raised one foot by the consumption of one hundred pounds of fuel, is the generally accepted standard of comparison, and it is the true index of the merits of a machine when it is the result of long continued operation, considered in connection with the other items above specified.

A saving of a small amount of fuel each day is augmented into a large sum in a year, and represents the interest on a considerable outlay in construction.

Owing to the fact that in America it is mostly coal mines which require powerful pumping machinery, the "duty" of the apparatus has not been so jealously considered; for waste or culm is principally used for fuel, and the labor troubles have encouraged operators to employ cheap engines to a considerable extent, rather than economical ones of more expensive construction. But at these mines each ton consumed cost something to remove and handle, and therefore represents value.

An engine which is required to raise three hundred thousand (300,000) cubic feet (or two and a quarter million gallons) per day to a height of two hundred feet, would perform a work each day equivalent to raising 3,750,000,000 pounds one foot high. If this engine was capable of working with sufficient economy to give an average duty of sixty million foot-pounds (a duty within safe bounds), the daily consumption of coal would be 6,250 pounds, aggregating in one year 1,018 tons; if, however, it gave no higher duty than the average of American pumping engines, say twenty-five million foot-pounds, the daily consumption of coal would reach 15,000 pounds, aggregating in a year 2,444 tons, a difference in favor of the 60,000,000 engine of 1,426 tons. If this fuel cost but one dollar per ton, the saving would pay for at least two laborers' time, or if capitalized at seven per cent. would permit of an expenditure of $20,367 more for a 60,000,000 engine than for a 25,000,000 engine.

In mines where ores of the useful metals are extracted, the saving would be much greater, and in proportion to the cost of the fuel. If coal cost $4 at such a mine, the saving above would be quadrupled, and amount each year to $5,703, representing a capital invested of nearly $81,500—a sum amply sufficient to pay for a very elaborate pumping engine of more than double the power above cited.

For many years the "duty" of pumping engines has received prominence in European mining countries, and most of the reliable data which we now possess are the results of the operations of engines at foreign mines. The English operators deemed it so important that prizes were offered to engineers doing the most work with 100 pounds of coal. While this had the effect of showing what the engines would do, and improving the average duties, it also brought into existence the various plans of "doctoring" pumping engines to secure empirical and excessive duties by the exercise of sharp practices, thereby detracting from the reliability of some of the reports.

In America the records of duties are principally from water-works engines, but, unfortunately, many of them are the results of but a few hours running, under the most favorable circumstances, and with numerous allowances for imaginary contingencies, and do not indicate the daily operation of the engines. The duty of an engine is not to be considered the result of such a test, but it should be calculated from the water raised and coal consumed in a year or a series of years.

The liability to disarrangement of parts, breakage,

* A paper read before the American Institute of Mining Engineers at the New York meeting, February, 1877.

and consequent repairs exists, of course, in all machines to a greater or less extent; the ratio being practically in proportion to the number of moving parts, and not to the weights of the machines. Care in proportioning, and attention to details of construction, greatly reduce the possibilities of accident, but the more numerous the wearing parts, the greater are the probabilities of repairs, and, generally, the shorter the life of an engine.

A pumping engine may give a high "duty," and yet be so short lived as not to be an economical machine, for the numerous stoppages and expenditures required for repairs, or the rapid deterioration of the engine, often amounts to more than the saving in fuel.

The cost of attendance, while entering into the calculation of the economy of an engine, does not attain the importance often ascribed to it, for the maintenance of any large piece of machinery demands (and should receive) careful and constant attention from competent parties, and cheap engineers are among the most expensive features which can be introduced into any establishment. There is no just reason why a pumping engine should not receive as jealous and watchful care from skilled attendants as a blowing engine or rolling-mill engine, and yet some pumping machines are claimed as superior to others because "any boy can run them."

The amount of lubricants required for an engine are given a place in the comparison of different apparatus, not so much for the sum expended upon them (although this, in many instances, is no small outlay), as for an index of the durability of a machine, for generally the engines requiring excessive lubrication wear rapidly, and consequently are "short lived."

The interest upon the first cost of an engine, very properly, is considered in the estimate of its efficiency; but it is often accredited with more importance than is justly due it.

The consumption per day, or 100 lb. of coal, or of a quart of good lubricants, or a half-hour's work in the machine-shop for repairs, will, under ordinary circumstances, represent a greater amount per annum than the interest on a thousand dollars; therefore, where all these items are increased in any engine, its economy becomes doubtful, and any saving in its first cost is quickly absorbed by such daily expenditures.

These remarks apply to pumping engines without unnecessary ornamentation, for this should be a matter of separate consideration. Any good machine is worthy of a good workmanlike finish, and the addition of gilding, nickel plating, fancy turning or fresco painting is not to be estimated in the record of comparative economy. There are pumping engines now in use in this country which have cost, to put in place, over $300,000, yet I greatly doubt if there is in America a pumping engine worth, intrinsically, to-day $100,000.

A pumping engine is a compound machine, made up of a steam engine (or the essential parts of one) and a pump (or pumps) combined, connected and arranged in a great variety of forms.

The proper proportion and arrangement of the parts of an ordinary steam engine are now so well understood and generally agreed upon, that, as a motor for converting the steam generated in boilers into work, there seems to be but little room for further improvement, and the direction of invention is rather towards obtaining better results from boilers.

Among the acknowledged essential elements for obtaining economic operation in a steam engine are high piston speed and expansion; and a large majority of pump manufacturers consider slow piston speed as necessary to secure a high duty in pumping engines.

In dealing with such a ponderous and unyielding substance as water, there are many difficulties to be overcome in making a pump to work at a high piston speed, and it may be considered impossible to be able to operate a pump with the same velocity as is practicable with an engine using the lighter and more elastic form of water (steam) only.

The attainment of moderately high speed in pumping engines is, however, easily accomplished, and well-proportioned pumping engines of large capacity, which are provided with ample water-ways, and properly constructed water-cushioned valves have been (and are now) operated successfully against heavy pressures, at a speed of 250 feet per minute, without "thug," concussion, or injury to the permanency of the apparatus, and there is no doubt but that the speed can be still further increased.

Although the pump for raising water ante-dates the steam engine by some thousands of years, and is a more simple machine, yet, in the proportioning and constructive arrangement of parts, there appears to be no acknowledged standard.

The pumps are made to force or push the water, or simply to lift the water; there are double-acting piston pumps, plunger pumps, or bucket and plunger pumps. They are worked singly, or in pairs or more, so connected as to deliver the water at different intervals.

If we add to these the rotary and centrifugal pumping machines, and the numerous arrangements introduced to lift water by the condensation and force by direct pressure of steam, we have a variety whose name is Legion.

In the details of pumps of a similar class, there are as radical differences. Valves are made hinged or "flap," "poppet," "single-beat," "double-beat," or "treble-beat" (I prefer the expressions single, double, or treble seat as more expressive). They are made of leather, rubber, wood, brass, composition, or iron. In proportions they are constructed large enough to answer for each operation of charging or emptying the pumps, or they are divided up into a number of small valves.

In fact, there is in pumps no acknowledged and accepted general arrangement in which intelligent mechanics and builders approximate an agreement.

In combining the two essential parts of a pumping engine, the steam engine and the pump, there is as much difference of opinion and controversy as to the mode of connecting and the arrangement of the parts. Some are operated direct, the piston of the steam cylinder being connected directly with that of the pump; others have intervening gearing, beams, or bell-cranks.

A visit to the pumping works supplying our large cities will demonstrate the variety of design and arrangement adopted by various engineers; nor is this variety confined to the different cities, for many of them have, as a means of supply, engines differing materially; and the city which uses engines of similar design and construction is the exception rather than the rule.

The city of Philadelphia employs sixteen pumping engines in connection with its water supply, which represent ten distinct varieties. Providence employs four pumping engines, all of radically different types. Buffalo, Cleveland, Cincinnati, and other large municipalities, are similarly provided.

To secure the advantage of a high piston speed in the steam engine, and operate the pump at a slower velocity, numerous designs have been introduced. One of the largest engines of late construction, built to secure this result, is a vertical compound steam engine, transferring its power through gearing to horizontal pumps. The great objections to such a design are the multiplicity of parts, and the difficulty of procuring gearing which will operate without back-lash or play between the cogs.

Another engine, which is also of late construction, consists of a compound engine, each cylinder operating a pump by means of a rocking or oscillating beam, the connecting rods of the steam cylinder and of the pump being so disposed that the steam piston passes through double the stroke of the pump piston, but the same number of strokes are made in a given time, and the difficulty generally experienced is in the change of direction of the water, and the opening and closing of the valves, and not in the actual speed of the piston.

In an article published in one of our engineering journals the untenable position is taken that a multitude of small valves offer less resistance to the flow of water through them than one large valve; while practice demonstrates that large valves offer less resistance proportionately than a number of small ones aggregating an equal area; and if double-beat valves are employed of appropriate construction, they will close as soon as the current of water ceases to flow through them, without the addition of weights or springs or the return current of the water.

In using a number of small valves it is found necessary to load them, or to hold them down by springs, particularly if they are of rubber, to insure their closing; and even it is rarely found that they all close properly; an examination of a pump using such valves generally exhibits some of them chipped or held partly open, and a consequent loss resulting.

A valve should be complete in itself, and the necessity of the employment of extraneous forces to produce the proper operation of the valves is evidence of a defect of construction or a want of adaptability for the purpose for which it is employed.

In a recent test of a pumping engine an allowance is made for a pressure of six pounds per square inch for the operation of each set of valves; this seems excessive, for it reduces the suction power of the engine so that it cannot draw the water over eighteen feet.

A large valve is now in operation which offers a resistance of but 0.63 of a pound per square inch, or but one-tenth that just mentioned. This resistance is 382 per cent. of what is credited to the Lynn engine, and 85 per cent. of what, as stated, is required to lift the valves on the Lawrence engine.

The pumping engine which best meets the peculiarities of both steam and water is what is known as the Cornish engine, practically the Bolton and Watt single-acting engine.

The advantages of this class of engine is that the in-door or steam stroke of the cylinder can be made quickly, and the out-door or pumping stroke is made slowly, while the water is discharged as the weighted plunger settles; the steam passing from one end of the cylinder to the other, and forming an equilibrium during the interval between the steam and pumping stroke; and the connection with the condenser being made in the interval between the pumping and the steam stroke.

This form of engine is particularly useful in mines and shafts requiring long operating rods; and for general purposes, when a considerable volume of water is to be elevated, it may be considered as the most economical and durable type of pumping engine. This may be deemed a bold assertion in the face of published reports of some late tests; but I am convinced that a Cornish pumping engine properly proportioned, constructed and managed, will give, during its continued operation, equal if not superior economic results to any other form of pumping engine.

One great advantage of this class of engine is the variety of speeds at which it can be operated. I have seen a Bull Cornish engine capable of raising 1,250,000 gallons to a height of 230 feet, operating satisfactorily at speeds varying from 20 strokes per minute to one stroke in three minutes.

That class of direct-acting pumping engines without fly-wheels, the "tappet pump," is, on account of the press and judicious presentation to public notice, probably more popular than any other form at present. In their construction marked ingenuity has been employed, and where the work to be done is comparatively small, or the uses for which they are employed are of a temporary or supplementary character, they answer a very good purpose; but they do not prove to be either durable or economical in their operation.

In a recent defence of this class of engine, an attempt was made to demonstrate that a crank controlled by a fly-wheel and the motion of the piston or plunger of a pump, produce a constant damaging conflict of forces, which not only absorbs a large percentage of power, but also tends to destroy the machinery.

The motion of the piston of a pump, produced by a crank with a fly-wheel of sufficient momentum to maintain a uniform velocity, is from rest at the "dead-point," by accelerated velocity, to a full stroke at 90 degrees, and from that point, by constantly diminishing velocity, to the opposite dead point, where there is sufficient rest to permit of valves seating themselves, and the direction of the water changing, the return stroke being from the "dead point" by accelerated velocity to 90 degrees, and thence, by decreasing velocity, to rest again. These so-called conflicting forces only come into play when a high degree of expansion is attempted with a single steam cylinder directly connected to the pump; and hence one of the objections to the Cornish engine. To secure the full value of expansion it is necessary to use a fly-wheel, or other heavy moving part to absorb the excess of power at the early part of a stroke, and give out power at the latter part of the stroke. Steam entering the cylinder of a Cornish engine strikes a blow (so to speak) upon the massive portions of the engine (which are constructed to receive this blow), and gives to the piston a momentum which is accelerated while the steam follows it, and then retarded as the steam expands, until the pressure of steam and weight of the

moving parts are in equilibrium at the end of the stroke. Admitting, then, the conflict of forces, does not the value received by expansion more than neutralize any additional cost in the proportioning of an engine?

By using a compound engine and expanding from one cylinder to the other, and constructing the pumps in duplicate, a moderate degree of expansion is obtained with tappet pumps; but this duplication of parts is, in plain words, the construction and maintenance of an entire steam pumping engine in place of a simple and inexpensive fly-wheel, with practically no wear, or expenditure for maintenance.

Very superior engines, and those which rival the Cornish in economic duty, are constructed with compound steam cylinders, bucket and plunger pumps, beam and fly-wheel, the compound cylinders in connection with the fly-wheel permitting a high degree of expansion.

Special conditions may make one form of pumping engine more desirable than another, but under ordinary circumstances, where a large volume of water is to be lifted to a considerable elevation, the superiority of well proportioned and constructed pumping engines may be considered to rank as follows for economy:

1. Cornish, or single-acting engines.
2. Compound engines, with fly-wheel.
3. Condensing engines, with fly-wheel.
4. Compound engines, without fly-wheel, duplex pumps.
5. High pressure engines, with fly-wheels.
6. Condensing engines, without fly-wheel.
7. High pressure engines, without fly-wheel.
8. Rotary and centrifugal pumping engines.

It is hardly fair to place the rotary and centrifugal pumps among pumping engines requiring to be in constant service under heavy work, but they have been brought so prominently into notice that they deserve mention. The rotary engine and pump possess in theory so many apparent advantages that great ingenuity and much money have been expended in attempts to perfect a reliable apparatus.

One design proposed for mines demonstrated that the inventor had been so impressed with the rotary principle that he introduced obstructions in the delivery part of his pump, which, in connection with wings or blades on the revolving shaft, kept the water in a rotary motion regardless of the fact that all the power expending in rotating the water was entirely lost, so far as lifting it was concerned.

Another inventor constructs his delivery pipe of a series of inclined planes, changing in direction every few feet, under the impression that water will ascend in a zig-zag course with its increase of resistance more readily than in a solid vertical column.

This paper is, however, not intended to discuss particular machines, but only in a general way classes of pumping engines, and the above are introduced as instances of devotion to the rotary class. It is rather the principles of construction with which it is intended to deal, hence there is no reference of comparative duty tests. This I have reserved for future consideration, and shall be pleased to receive records of any pumping engines accessible to the members of the Institute.

In ascertaining the duty or actual commercial value of such an important machine as a large pumping engine, there need be no difficulty in arriving at an exact measure of comparative economy and merit, without resort to hypothesis or guessing at results. All the elements entering into the intelligent understanding of the subject are easily ascertained. They are

1. Fuel actually consumed, with oil, packing, etc.
2. Weight of water delivered × height lifted × friction.
3. Reliability and durability.
4. Attendance and repairs.
5. Comparative first cost.

These facts can all be obtained and the results readily worked out to the satisfaction of any one interested in the operation of pumping engines. In some of the records of empirical tests there seems, however, to have been so much high art and scientific ability displayed that even to those with moderate attainments in mechanical engineering the *modus operandi* of securing the result is a mystery.

It has been claimed that the indicator is the best means of determining the relative value of pumping engines, for it tells the tale of the inside workings of a pump or steam cylinder. Recognizing the value of indicator diagrams, I cannot conceive that they are as valuable in comparing various pumping engines as the record of the coal heap and the discharge weir. Comparison by indicator diagrams are likely to be unjust unless they are taken with the same or a similar instrument, located in like positions on the various engines, and given in connection with the speed and work performed by the different machines.

The contraction of water-ways, proportion and kind of valve also have a marked effect upon the appearance of cards taken from a pump cylinder.

While indicator diagrams are of great service to the engineer, and their comparison has done much to improve various motors, there are so many affecting causes to be considered that it is difficult to make satisfactory comparisons of the records of different parties. A candid comparison of the elements proposed in this paper will give a just precedence to good engines, and I am convinced will sustain the relative order of merit as given.

DISCUSSION.

The chairman said he was glad to hear this subject brought forward in a place and atmosphere where it could be, he trusted, discussed without passion or the bias of pending personal interest; and he took pleasure in recognizing the strictly professional tone of Mr. Birkinbine's paper, it being well known that that gentleman's business relations were such as to tempt him to a different style. With reference to the reported high duties of Cornish pumping engines, he begged to refer to an article in the *Engineering and Mining Journal* of March 5, 1877, where his views had been expressed. The great excellence of the Cornish engine as a mine-pump was, however, admitted.—*Engineering and Mining Journal.*

PERSONAL.

J. Francis LeBaron, C. E., of Boston, has been commissioned to make collections in Natural History and to carefully examine and study the aboriginal remains, etc., of Florida, for Harvard University, the Smithsonian Institute of Washington, the Essex Institute of Salem, and others, making Jacksonville his headquarters.

ON THE PROBABLE ERRORS OF LEVELING; WITH RULES FOR THE TREATMENT OF ACCUMULATED ERRORS.*

BY WILFRED AIRY, B. A., M. INST. C. E.

(Concluded from page 98.)

Mr. Adie observed that no reference had been made to the refraction of light. He believed that if there was an error in leveling in one direction compared with leveling in the other direction, the probable cause, in some degree at least, must be from the refraction of light. This was explained to some extent, by the fact that the tables showed that the Indian levels were, on on the whole, much more accurate than the English. Whether that was from the purer atmosphere, or not, he did not know, and the same indeed applied to the Swiss. In the transit of a star refraction did not matter, because it was equal on both sides; but it was not so in leveling, and probably this was the cause, in some degree, of the different results obtained in leveling in the different directions.

Major Courtney, R. E., observed, through the Secretary, that the method proposed by the Author, though certainly ingenious, and doubtless securing a high degree of accuracy, was, in his opinion, far too complicated and involved too great an amount of office work to be of much practical use. Besides, from an inspection of the Indian leveling results, it appeared that, owing to the strict precautions used to prevent any large differenc accumulating in the work of two observers, their results left little to be desired in point of accuracy, and this without all the laborious calculations of the proposed method. Their system of getting rid of cumulative errors in the field involved but little computation, and was far better for practical purposes. With respect to the English results being so inferior to the Swiss, he found that the latter, in order to get the best results, took the utmost pains, and used every instrumental refinement, even putting highly-trained officers on the work to make the observations. It was then only to be expected that their work should be superlatively good; on the other hand it must be far more expensive per mile. He thought this should be stated in fairness to the English work.

Mr. Airy, in reply, drew attention to two levels lent by the firm of Troughton and Simms. One was an ordinary dumpy level, the other "The Italian Y level," designed by Mr. Simms according to a plan well known on the Continent. The latter had all the proper movements for easy adjustment in collimation, and the level was not, as usual, attached to the telescope, where it was liable to knocks, but to the frame, where it was much more sheltered. Levels of that size were not used for the standard leveling of countries; they were far too insignificant for that work; but they were convenient for engineering purposes. It had been remarked that the degree of accuracy mentioned in the paper had little reference to ordinary engineering operations. That was perfectly true; but of course there was no reason why one should not search for greater accuracy than was ordinarily necessary, and for geodetical purposes—and the paper was more directed to geodetical purposes than engineering works—a high degree of accuracy was necessary. It had also been said that errors caused by the waving of the staves, and so on, were not of great consequence, because if an error was made going up hill it was cancelled in coming down; so that if the operations were completed at pretty near the same level from which they had been started no large final error would have crept in. But in leveling over several hundred miles, going up a height of several thousand feet, and down again, the top point was very likely to be a great deal in error. No doubt Mr. Bunt's leveling, which Mr. Barlow had referred to, was quite historical in its way. It certainly was found out by Mr. Bunt and Dr. Whewell for the first time, that if levels were made in one direction to a distant point and then back again, different results were obtained—in fact, that there was a kind of orientation in leveling—that in lev- from north to south a different result was got from that obtained by leveling from south to north. That had been amply verified by Colonel Walker in India who, in one of his reports, described the source of the error, which he believed to be the most significant of all causes of error, and said; "A good deal of uncertainty exists in reading the level, owing to its being usually placed above the telescope and nearly in the the same plane as the eye of the observer, who gets a side view of the bubble, which is never as satisfactory and sharply defined as the look-down view from above. The r m round the bubble, caused by the adhesion of the liquid to the sides of the tube, becomes so prominent that in certain lights its extremities may be taken for the ends of the bubble. When light falls obliquely on the instrument, the outer edge of the rim towards the light is more clearly defined than the inner, while at the opposite end of the bubble the inner edge is more clearly defined. Hence there is a tendency to bring the bubble too much towards the light, and give the reading an erroneous bias, which some observers might guard against more than others." That was how Colonel Walker explained the difference of the results obtained in going in one direction or another. With regard to the error arising from the effect of temperature on the length of the bubble, he did not think that it would be sensible with the best modern levels. In the Swiss leveling, and in the Indian leveling, the ends of the bubbles were always read. There was never any question of setting the bubble exactly true. It was set true within certain limits, and then the ends were carefully read and booked, and corrections applied for the amount it might be out of truth, so that there would little uncertainty arising from that source. Mr. Binnie remarked that there was an error due to the unequal illumination of the staves on going from east to west, or in any way in which the light fell very sharply. To reduce this short readings must be taken, so that the unilluminated could be read as clearly as the illuminated one. This would make the work a little slower. It was an error that came under the head of genuine errors of observation, and no doubt was included in the figures he had exhibited. Mr. Redman remarked that no doubt the reason why the English leveling showed badly as against the Indian and the Swiss was because it was executed in a hurry. He believed that was the case; but at any rate the English leveling was begun in 1844 when people

did not understand leveling so well as now. The care given to the leveling in India and Switzerland was extraordinary, but the English leveling was comparatively antiquated. With reference to what Sir John Hawkshaw had said, he should have considerable doubts of any results or calculations referring to the mean level of the sea around England as deduced from the English leveling. The leveling was not good enough to prove things of so much importance, and the levels required to be checked over and over again with superior instruments and care. He did not think that any sensible error could arise from the elliptical form of the earth. The weight of the staff, no doubt, would operate if the ground was soft; but in all standard operations much more care was used than to place the staff on soft ground. In India a peg was driven to every position of the staff, and so each peg became, as it were, a benchmark. The succeeding observer who checked the work invariably put his staff on the same pegs, and so there was absolutely a benchmark from reading to reading the whole distance, and if a mistake crept in it could be located immediately and rectified. The Australian leveling mentioned by Mr. Arthur Woods undoubtedly was very good, and was on a par with modern good leveling, as shown in the paper. With respect to Major Courtney's remarks, he would state that the closing error of an extensive system of levels, however carefully the work was done, was almost certain to be too great to be disregarded, and needed to be dealt with in a formal manner. There was no short cut to such adjustments, and it would be seen by a reference to their reports that the Swiss engineers devoted an immense amount of labor to the adjustment of extremely small errors.

TO MAKE STONE WALLS WATERPROOF.

A correspondent asks for a process which will make stone walls waterproof. What is known as Sylvester's method has been thoroughly tested, and so far as we know has proved effectual. It is said to have been applied to the walls of the gate-house of one of the New York reservoirs, and to have remained impervious to water under a head of thirty-six feet after a trial of six years and a half. The process is described as follows:

"Dissolve Castile soap in water, three-fourths of a pound to the gallon; dissolve one half pound of alum in four gallons of water; both to be completely dissolved before using.

"The walls should be clean and dry, and the temperature of the air not below 50° (F.) when the solutions are applied. First with a flat brush lay on the soap wash boiling hot, taking care not to form a froth on the brickwork. Let this remain twenty-four hours, to become dry and hard; then apply the alum wash, which may be at a temperature of 60° or 70° and allow it to remain twenty-four hours before repeating the soap wash. Repeat the washes alternately till the wall is impervious to water."

"Water-glass," which is a silicate of potash or soda, has also been used successfully for the same purpose. The following, which the *American Architect* translates from Ramee's "Architecture Pratique," is a description of the original Kuhlmann process of silicatization:—

"The solution of silicate of 35° density (by Beaume's hydrometer), as found in commerce, contains one-third its weight of dry silicate (of potash or soda). Diluting a solution of this density with one and one-half times its volume of water, we obtain the most suitable degree of concentration for application to stone. With these directions, any one can prepare a suitable solution.

"To dissolve the dry silicate, if it is procured in that form, is difficult, but it is made easier by using, instead of pure water, water in which a little silicate is already dissolved. Pulverize the lumps, and, adding the silicated water, boil the mixture, stirring constantly.

"The proportion of the salt above indicated, viz., one part to eighteen of water by volume, in the liquid ready for use, is not essential, but a stronger solution penetrates the stone less readily, and a weaker one requires more applications. The last coat may with advantage be slightly more concentrated than the others.

"For applying the silicate, the stone must be perfectly clean. In old buildings it must be scraped to a new surface; or, if this is impossible, brushed with a stiff brush, and a lye of caustic potash. No acid must be employed. The solution is applied to large surfaces with a syringe and rose, first making troughs of clay at the foot of the wall to collect the excess of liquid. For small surfaces it is applied with a soft, thick brush, to take up as much solution as possible at once. Care must be taken to protect the windows with cloths, as the silicate will make spots difficult to remove.

"After each application an interval should be left of several hours, or better, a day. In general, three applications on three successive days will be sufficient. Too much of the silicate will give the stone a disagreeable glazed look, which must be rectified by washing the stone immediately before the silicate is hardened by the air.

"The process may be applied at any season, excepting in freezing weather, but warm and dry weather is preferable. If the sun is very hot, cloths should be laid over, to prevent too rapid drying."—*Boston Journal of Chemistry.*

A NEW IRON RAILWAY TIE.

The past twenty-five years has witnessed the grand development of the railway systems of the world, and keeping pace with it, great and vital improvements have been made in rolling-stock, permanent structures, and all methods of management; but in the matter of permanent way, the practice of to-day is essentially that of twenty-five years ago, and a majority of railway accidents are traced to what appear to be its insuperable defects.

This statement needs qualifying to a certain extent. The road-bed has undoubtedly improved through more efficient ballasting and better drainage, the fished-joint, though leaving much to be desired, is generally adopted; and lastly, the Bessemer metal rail has largely supplanted the iron rail, not that a carefully made homogeneous iron rail is poorer, but simply because railway managers would not pay the price of such rails conscientiously made. So with the exception of methods and details, and possibly the adoption of the fished-joint, the improvement in permanent way has been practically *nil.*

Formerly there was some difference of opinion as to the relative merits of longitudinal sleepers, giving continuous support, and cross-ties; but of late years cross-ties, spaced two to two and a half feet, have been almost universally accepted as giving the necessary elasticity combined with the requisite facilities for repairs. Stone blocks have been employed and are still to a limited extent but the devices lately invented to overcome their destructive rigidity have not proven satisfactory. Various forms of metal ties, chiefly cast-iron, have been recommended, but owing to their great first cost as compared with that of the common wooden tie and the absence of many of its characteristic qualities, they have not been able to compete with it except in tropical countries, where the wooden tie is subject to rapid decay and often to quick destruction by insects, chiefly white ants; also in districts where the scarcity of timber practically prohibits its use.

In this country the wooden cross-ties, we believe, are universally in use, and as long as a good oak tie can be obtained for 75 cts. the adoption of metal may be considered as doubtful, although we are persuaded that but for the inertia of railway companies they would see in it not only a direct economy in money, as we shall presently show, but an additional insurance against accidents from overturning rails and spreading of tracks. Already the need of a substitute for wood is felt in our lines across the plains. The rapid depletion of our timber supplies is exciting grave apprehensions in the minds of the thoughtful. Soon some system of forest culture must be instituted or timber in many of its present uses will be abandoned. When it has been stated that the cost of replacing the railway ties of this country is over ten million dollars annually, the magnitude of this item alone and of any proposed saving becomes enormous.

The average life of a railroad tie is about seven years

Let us assume certain data and make a comparison in order to determine how much a railway company can afford to pay for one of metal. Assume that a metal tie will last twenty-one years or three times the life of a wooden tie. Omit the minor factors such as surfacing, replacing rotten ties, and other repairs, which will vary in each case. Any discrepancies which may result will favor the wooden tie.

Take the cost of the wooden tie at 75 cts. delivered, and the spikes at 10 cts., the tie to be replaced twice and the spikes to last the entire time of 21 years. Then compounding at 6 per ct. the amount approximately of

85 cts.	for 21 years	$2.89
75 "	" 14 years	1.09
75 "	" 7 years	1.13
		$5.71

This represents a capital compounded at 6 per cent. of $1.68 which is the price that can be paid for the assumed metal tie. Compounding the interest at 10 per cent. the capital that can be expended is $1.43.

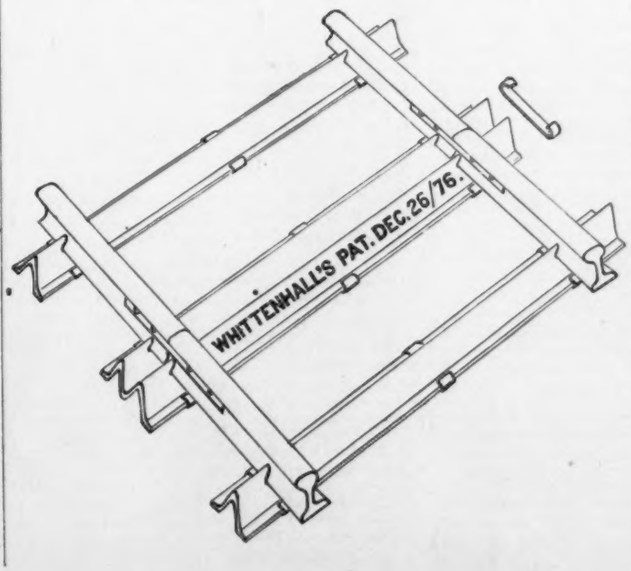
If we prefer to treat the problem in the ordinary manner, assuming the data as above and 1.12 cts. as the annual cost of keeping a tie and spikes in place, at 6 per cent., an invested capital of $1.87 would be required, and at 10 per cent., of $1.12, which sums at the assumed rates of interest might be expended on a metal tie.

If to this we add the fact that after the metal tie is worn out you have still a stock of iron which can be remanufactured, of course with some loss of material, and also, that every railroad company can turn its old rails and junk into ties for the cost of manufacture, the showing will appear exceedingly favorable to every railroad man.

Apparently conclusive experiments, recently made in England, show that steam injected into a reheating furnace, the iron being at a white heat, forms a skin, homogeneous with the iron, of black or magnetic oxide, which resists not only the corrosive effects of moisture, but even of the acids that ordinarily attack iron with avidity; subjected to some such process the life of an iron tie should be indefinitely prolonged.

The data assumed makes no pretensions to accuracy we being desirous of only relative results. We think a closer calculation by any railway engineer with complete data at hand will show that we have favored the wooden tie at many points. The assumption that a wooden tie can be bought 14 years hence for 75 cts. is probably far wide of the truth.

The above remarks have been suggested in part by an examination of the "*Whittenhall Patent Corrugated Metallic Railway Cross-Tie.*" This examination has convinced us that it possesses most, if not all, the essential requisites of a good railway tie, and at a cost sufficiently small to warrant its early introduction. Probably experience will show many advantageous improvements to be made in its construction, but we are persuaded that this or a similar structure will soon be a prime necessity.



The cut presented herewith illustrates the invention so well that a lengthy description seems unnecessary. The single tie has 8" earth bearing, the base of the equilateral triangle being 5", and the flanges 1½' each. The double or joint tie has 12" earth bearing, the flanges being 1" each. By the use of clamps on the bottom of the tie, it can be made much lighter; while by making the middle clamp tight and the outer ones somewhat longer sufficient play may be given to preserve the elasticity due to the shape. The earth when tamped fills the corrugations and is in a measure kept dry and hard. The rail seats are cut by a double horizontal punch of simple construction. The ties can be manufactured from old

rails, scrap or new iron, as the case may be, by simply piling and rolling into shape, and at a cost not exceeding that of any commercial iron, and probably less owing to the material allowable in their construction. When useless from rust they can be re-rolled as cheaply as any old iron.

Among the advantages claimed for this tie over those of wood are—there are no spikes used; there is no danger of the track spreading or rails overturning; it saves a larger amount of the section work after the track is laid, as there are no spikes to watch or rotten ties to look after; it lasts much longer, and it is cheaper in a term of years on most roads of this country, and cheaper in first cost at the present time on railways west of the Missouri river. Moreover, while a money saver, it is a great insurance to life and property. Neither is it liable to loss from fire, flood or theft. The elasticity of the tie means less wear and tear of rolling stock and rails. On account of less bulk and weight as compared with wooden ties, allowing cars to be loaded to their full capacity, they can be freighted long distances much cheaper. It will be seen that we have a sort of universal panacea for most of the evils of permanent way.

The inventor claims that with the use of a derrick car and eight men one mile of either old or new track can be laid per day, ready for tamping. When the tie is in place a stroke of the hammer clamps it to the rail. To remove a rail it is necessary to disconnect the fish-plates, shove the section aside, and after loosening the clamps draw it out. A tie may be removed when worn out by breaking the clamps. The results of a few calculations which we have made may be of interest as bearing out some of the foregoing statements.

The tie is assumed 66" in length and of ¼" metal. The weight of a single tie would be 60 lbs., and of a double or joint tie, 101 lbs., and costing at $42 per ton respectively $1.12 and $1.90 a piece; or with rails of the usual length, an average of $1.18. Taken in connection with previous figures this gives a practical saving margin.

The area of the section is 3.27 sq. in., and its moment of inertia about its neutral axis 4.285, assuming a tensile strength of 48,000 lbs.; the moment of resistance to bending is 70,000 approximately. This theoretical result is not to be depended upon as exact in the absence of experiment on this form of cross-section, but the true value cannot differ greatly. The heaviest freight locomotives (six wheels) have weights of 12,000 lbs. on each driver, and with the tie well tamped would produce a strain of approximately 12,000 lbs. at the middle of the tie. If thought desirable this strain could be lessened by lengthening the tie; thus a 7' tie would give a middle strain of approximately 7,000 lbs. If the tie were fixed at centre, as a cantilever, the strain would be only 28,000 lbs. The shearing strain approximately 3,500 lbs. per sq. in.; the crushing strain at rail seats, 6,000 lbs. per sq. in., and the factor on buckling of the sides not less than eight.

The detail calculations show that the material can be so distributed as to give greater strength with at least 25 per cent. less metal. Such shapes would be expedient should experience demonstrate the possibility of guarding against corrosion. They could be made by the aid of cam-rollers.

The invention we understand is soon to be tested by the laying of a considerable length of track on the main line and in the freight yards of one of our western roads. We hope to be able to speak favorably of the results.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

(From our Special Correspondent.)

NEW ORLEANS, *April 24, 1877.*

The main body of the American Society of Civil Engineers arrived in New Orleans last evening, having come from the east or west to Louisville, the place of rendezvous, and thence by special train via Mobile, where the whole party, sixty-six in number, stopped for several hours to visit special points about that city. Previously there had arrived at New Orleans various straggling parties, making the whole number registered at the St. Charles hotel last evening, nearly one hundred.

At 10 A. M. to-day the Society and its guests met at the Chamber of Commerce Building. The retiring president, Mr. Greene, being absent, the duty fell to Col. W. Milnor Roberts of delivering the opening address. In it he referred to the object of the meeting in this city, mentioned points of historic and general interest, in which the Father of Waters came in for the usual apostrophe, referred to the works now in progress at its mouth, etc. The growth of the Society from 50 in 1867 to 580 in 1876, and its accompanying results were duly treated. Altogether his address was quite happy and awakened repeated cheers.

After the reading of the address, that venerable student of hydraulics, Prof. Forshey, was elected Chairman which he gracefully accepted in his eccentric way by a neat little speech. Mr Bogart was elected Secretary pro. tem. and Mr. Emery his associate.

The Secretary read a communication from the city Fathers giving the freedom of the city to the members of the Society and guests, and a committee was appointed to confer with them on arrangements for visiting objects of interest in the city and vicinity.

On calling the roll the following members were found present:

James Archibald, Washington, D. C.
Wm. H. H. Benyaurd, Capt. of Eng's, Memphis, Tenn.
John Bogart, Eng. Dpt. Public Parks, N. Y.
Adolphus Bonzano, Pœnixville, Pa.
Louis G. F. Bouscaren, Ch. Eng. C. S. R. R., Cincinnati, Ohio.
Elmir L. Corthell, Asst. Eng. Jetty Co., N. O.
David W. Cunningham, Asst. Eng. Boston Water Wks.
Oliver E. Cushing, Lowell, Mass.
F. De Funiak, L. & N. R. R., Louisville, Ky.
J. E. Earley, C. S. R. R., Cincinnati, Ohio.
Henry Earnshaw, Cincinnati.
Ellis S. Clarence, Boston, Mass.
Chas. E. Emery, New York City.
F. U. Farquhar, Maj. of Engs. U. S. A.
Albert Fink, Louisville, Ky.
J. F. Flagg, Meadville, Pa.
C. G. Forshey, New Orleans, La.
W. F. Foster, Nashville, Tenn.
J. B. Francis, Lowell, Mass.
Edward D. Frost, New Orleans, La.
J. P. Gould, Roundout, N. Y.
John Griffin, Phœnixville, Pa.
Clemens Herschell, Boston, Mass.
Max Hjortsberg, Chicago. Ill.
C. W. Howell, Capt. of Engs. N. O., La.
W. E. Kelley, New Brunswick, N. J.
E. C. Lewis, Nashville, Tenn.
T. D. Lovett, Cincinnati, Ohio.
John MacLeod, Louisville, Ky.
Chas. MacRitchie, Milwaukee, Wis.
Niles Meriwether, McComb City, Miss.
Robt. Moore, St. Louis, Mo.
E. S. Philbrick, Boston, Mass.
F. C. Prindle, Philadelphia, Pa.
A. L. Rives, Mobile, Ala.
W. M. Roberts, New York.
Wm. Rotch, Fall River, Mass.
Wm. H. Searles, Rochester, N. Y.
W. Sooy Smith, Maywood, Ill.
C. H. Strong, Cleveland, Ohio.
E. W. Vaughan, Louisville, Ky.
C. D. Ward, Jersey City, N. J.
H. M. Wightman, Boston, Mass.
W. H. Wiley, New York.
W. E. Worthen, New York.
Wm. H. Newton.
E. N. Doane, Meadville, Pa.
D. E. MacComb, Washington, D. C.

ASSOCIATES.

Arthur Beardsley, Swarthmore, Pa.
C. B. Brush, Hoboken, N. J.
E. C. Davis, Northampton, Mass.
Robt. Fletcher, Hanover, N. H.
C. M. Harris, New York.
Authur Spielman, Hoboken, N. J.

JUNIORS.

J. B. Davis, Ann Arbor, Mich.
A. R. Hill, West Haven, Conn.
Alfred Noble, Detroit, Mich.
F. O. Whitney, Boston, Mass.
Samuel Whinery, Chattanooga, Tenn.
Sanford Horton, New York.
F. Brooks, Boston, Mass.

MISCELLANEOUS.

Fred W. Merz, (fellow) Louisville, Ky.
Chas. R. Flint, (fellow)
C. F. Allen, (guest) Boston Society.
E. Powell, " Chicago, Ill.
Geo. C. Morgan (guest) Engineer's Club of N. W., Chicago, Ill.
J. H. Gardner, (guest) New Orleans.
J. a d' Hemecourt, (guest) City Surveyor, N. O.
P. M. Moore, St. Louis Club.
Benj. H. Harrod, (guest) New Orleans.
Thos. S. Hardee, " New Orleans.
H. P. Darock " Detroit, Mich.
C. A. Henry, " New Haven, Conn.
R. L. Engle " Chattanooga, Tenn.
Prof. W. Watson, " Boston.
Arthur May, " N. Y. City.
L. E. Cooley " Eng'rs Club of the N. W., Evanston, Ill.
M. T. Endicott, (visitor) New London, Conn,
Maj. C. H. Boyd, (guest) U. S. Coast Survey, N. O.
Maj. A. J. Wrotnowski, (guest) New Orleans.
J. A. Hayward, (guest) New Orleans.

Many others are expected which will extend the above list and make this one of the best meetings ever held by the Society.

After the roll had been called and visitors' names enrolled the Secretary read the programme, for the most part as given in the NEWS of last week. The convention dinner is to be held at Lake Ponchartrain on Thursday. The business meeting was fixed for 3 P. M. of Wednesday. In the meantime Lieut. Davis stated to the Society the fact that Capt. Eads was kept away from this meeting on account of sickness and expressed the hope that he might be able to be present before the Society left the city.

The first paper discussed was that by Chas. MacDonald, on the Ashtabula Bridge. Remarks were offered by Robt. Briggs, Theo. Cooper, Chas. Newton, Mr. Searles, C. Shaler Smith, and others, the general conclusion being that astonishing incompetence was displayed in its design,—and as one writer remarked, the only fact of value to be drawn from the catastrophe was that a bridge with a factor of safety of one and one-tenth had stood eleven years,—and that the inspection was very inefficient. The general remedy proposed was official inspection by men entirely separate from corporate interest, either appointed by the general or State government, and a recommendation that a committee of four from the Society be appointed to draft a law, and that individual members interest themselves in procuring its passage in the various States, so as to secure practical uniformity in its workings.

At this point an invitation from Capt. Cowden was read inviting members to visit the Barataria Ship Canal Route to the Gulf, and that a small steamer would be ready to take such as wished to go on May 1st, returning on the 2d. After thanking Capt. Cowden for his invitation the Convention took a recess for half an hour to meet again at 1:30, P. M.

After the meeting re-commenced, the Society listened to a paper by Mr. Chas. Emery on the Relative Quantity of Materials in Girders of different types.

The paper was highly analytical and critical—treating of the relative depth, angle of braces, ties, etc., by which a girder could be constructed of a minimum weight or cost, the equation of values being of the 1st degree only, and allowing of the introduction of factors representing wood and stone, in fact all that enters into bridge structures. The paper was evidently regarded as of high analytical value.

A Discussion took place on special points by Gen. Smith, Mr. Bouscaren, Mr. Griffin, Mr. Philbrick, and others.

A paper was then presented by Maj. Howell on the Improvement of Galveston Harbor, in which the Gabion method of making piers or walls for directing the current and consequent scour was described. This work has been previously described in the columns of the NEWS, and it is not necessary to notice it here.

A paper was presented by the Secretary for Gen. J. G. Ellis on the Flow of Water in Rivers, in which some late European discussions and formulæ were treated analytically. The paper is one of great value to the student of hydraulic engineering. Some very interesting remarks on the flow of water in the western levels

of the Erie Canal were made by Mr. Searles; and the errors in leveling of the 136 miles discussed. The remarks will undoubtedly be published, and we defer further remarks until such time.

Prof. Forshey spoke of Humphrey's and Abbott's formula in regard to the flow of water in the Mississippi, and of the necessity of further investigation into the flow of water in large rivers.

Mr. Corthell had not prepared a formal paper, but ofiered many interesting remarks on the works at South Pass as being on the general problem of river hydraulics. The first part of his remarks have already been furnished by the article in the NEWS of last week. Mr. Corthell was exceedingly frank in his remarks, confessing that they had been in a measure over-confident, but they were learning every day. The problem was by no means solved. Many things that they had tried had failed without apparent reason, and quite different expedients had to be adopted. The results of the work during and since the March rise had been very gratifying, and was very encouraging, and the project is now in a fair way to success. He then explained the works now executed, giving statistics and facts as to their general utility, which, for the most part have been published in these columns.

After some minor remarks, the Society adjourned at 4 P. M. until 7:30 P. M.

CONTRACTORS' INTELLIGENCE.

One of Alger's friction excavators, in use by Farwell, Sage & Co., Contractors, at Long Island City, N. Y., excavated 217,000 cubic yards of earth last year.

Mr. John G. Nepps, of Lebanon, Ohio, was recently awarded the contract to build all the bridges on the narrow gauge railroad near Cincinnati, Ohio. The contract will occupy nearly a year to complete.

The contract for furnishing and laying pipes and gates was awarded to Delos A. Chappell, for $192,246-50. The gates on the Chapman pattern. All hydrant bids were rejected.

The Water Committee of Allegheny, Penn., lately awarded the following contracts: Water pipes and sleeves to John N. Smith at from $28 to $32.25 per ton for pipes, according to sizes, and $55 per ton for sleeves. Miscellaneous castings to Thomas Carlin at 1 6-9 cents per pound. Fire plug boxes, stop cock boxes, washout boxes, at $1.50, $2, $3.50 and $5 per box.

The plan submitted to the Keystone Bridge Co. for the proposed bridge to carry the tracks of the New York, New Haven & Hartford Railroad over Bridge street in Springfield, Mass., has been adopted, and the contract for furnishing the ironwork awarded to the Keystone Co. The company has also about completed a pivot bridge 186 feet long for the old Colony Railroad at Somerset, Mass.

The Hon. Mr. Chauveau, President of the Harbor Commission, and Jos. Sheyhan, M. P. P., arrived back from Ottawa, on the 16th inst., and reported a satisfactory and gratifying result to their mission relating to the extra sum required to fully carry out the proposed harbor works at Quebec. They entered into arrangements with the Government on the subject which will admit of the contract immediately, and the inception of the undertaking at an early date.

The contract for the grading Superstructure and Ironing of the Waynesville, Port William and Jefferson Narrow Gauge R. R. was let to Geo. Pots & Co., of New York at $7050 per mile to be completed Jan. 1st, 1878. This line of 26 miles by its connections with the Dayton & South Eastern, and the Springfield, Pomroy & Jackson Narrow Gauges at Washington its eastern terminus and the Miami Valley at Waynesville, its western terminus gives a direct Narrow Gauge line from Cincinnati to the Jackson county Coalfields.

We are favored with the following information from Pawtucket, R. I., in relation to the Water Works Contracts:

The contract for Pumping Engine was awarded to the Corliss Steam Engine Co., Geo. H. Corliss, Treasurer. The engine is to be capable of delivering three million gallons of water in twenty-four hours into a reservoir 240 feet above the water in the pump wells or under an equivalent pressure. The duty guaranteed is 80 millions in a trial of two weeks running ten hours a day, new fires to be made each day and all wood used in kindling to be reckoned on the basis of 100 lbs. wood to 45 lbs. coal, no allowances to be made for ashes and clinkers, and 100 millions duty in a 24 hours trial conducted in the usual manner of conducting duty tests. The price of the engine, pumps and boiler complete is $23,900.

The contract for building No. 1 Dam on the Sudbury river for the Boston Water Works was awarded to Messrs. Beckwith & Quackenbush of Herkimer and Mohawk, N. Y. The following are the quantities of work with the prices bid;

12000 cu. yds. of earth excavation, 40 cts. per cu. yd., 900 cu. yds. of soil dressing, 30 cts. per cu. yd.; 350 cu. yds. broken stones, placed, $3.00 per cu. yd.; 100 cu. yds. cement concrete, $5.00 per cu. yd.; 60 cu. yds. brick masonry, $15.00 per cu. yd.; 250 cu. yds. riprapping, $3.00 per cu. yd.; 800 cu. yds. dry rubble stone paving, placed, $3.00 per cu. yd.; 1900 cu. yds. rubble stone masonry in mortar, $6.00 per cu. yd.; 30 cu. yds. split stone coping, $15.00 per cu. yd.; 20 cu. yds. floor paving, $20.00 per cu. yd.; 1250 cu. yds. cut dimension stone masonry in mortar, $18.80 per cu yd.; 2800 sq. ft. face dressing of six cut work, 25 cts. per sq. ft.; 8500 sq. ft. face dressing of pointed work, 15 cts. per sq. ft.; 3 M ft. B M spruce lumber placed, $3 .00 per M. Total amount of tender $48,485.00.

The bids for the superstructure of the bridge over the Tennessee River six miles north of Chattanooga, Tenn, on the Cincinnati Southern road, were opened by the trustees March 2d. The bridge, the masonry for which is already completed, is to be an iron truss bridge of eight spans, one draw-span, 280 feet; one channel span, 256½ feet; two shore spans, 208¾ feet each, and four other spans, 207½ feet each, or 1,784 feet in all. There were eight bids, as follows: Phœnixville Bridge Works, Clarke, Reeves & Co., $:17,355,90; Louisville Bridge & Iron Co., $132,744.00; Claflin & Sheldon, Cleveland, O., $134,661.00; Detroit Bridge Co., $156,-000.00; Keystone Bridge Works Pittsburgh, $156,-026.05; Baltimore Bridge Co., $157,202.50; Keystone Bridge Works (second bid), $159,102.10; American Bridge Co., Chicago, $184,057.00. The contract was awarded to the lowest bidders, Clarke, Reeves & Co. A press dispatch from Cincinnati says: Clarke, Reeves & Co., of Philadelphia, declining to sign the contract for the Tennessee river bridge on the Cincinnati Southern railroad, the contract was conditionally awarded to the Louisville Bridge and Iron Co.

Editor ENGINEERING NEWS.

SIR.—Proposals, twenty-seven in number, were opened on the 11th inst. for the improvement of Tiber Creek Valley, D. C., for which an appropriation was made by Congress last session. The work was divided into three parts:—Improving K st. N. between 1st and 3d sts. E.; filling different streets, and sewerage. The approximate estimate of quantities for the improvement of K st. was as follows: 19,122 cu. yds. earth excavation including a haul of 200 feet; hauling earth per cu. yd. per 100 feet over 200 feet; replacing 1771 lin. ft. 12-inch flag, 2375 lin. ft. 16-inch flag, 2087 lin. ft. 5 x 20 inch bluestone curb, 2525 sq. yds. brick sidewalk, 1420 sq. yds. cobble stone paving, and 4624 sq. yds. graveled roadway.

Highest bid for excavation, J. Danaher, at 40 cts. per cu. yd.; lowest, O. O'Hare, at 10 cts. per cu. yd.; highest bid for hauling, D. L. Roach, at 1⅞ cts. per sq. yd. per 100 ft.; lowest, T. Joyce, at ⅛ ct. per cu. yd. per 100 ft.; highest bid for replacing material, J. Danaher, $4,300.00; lowest, O. O'Hare, $1,796.00. The contract was awarded to P. Brennan at eleven (11) cents per cu. yd. for excavation, one-fourth (¼) cent per cu. yd per 100 ft. for hauling, and $1,800.00 for replacing material. Filling different streets, the contractor to furnish the earth, which is to be measured in embankment, and without reference to shrinkage or swelling. Total amount of embankment, 41,950 cu. yds.; highest bid for same, T. Kirby, at 33 cts. per cu. yd.; lowest, C. H. Eslin & Co., at 15 cts. per cu. yd. The contract was awarded to T. Joyce, at 17 cts. per cu. yd. The sewerage consists of 572 lin. ft. of 36-inch two ring circular brick sewer, 488 lin. ft. of 24-inch two ring circular brick sewer, 906 lin. ft. of 18-inch pipe sewer, and 54 lin. ft. of 15-inch pipe sewer, all with lateral connections, man-holes, etc., complete as per plan. Highest bid for 36-inch sewer, D. Looney, at $4.00 per lin. ft.; lowest. H. Himber, at $1.81 per lin. ft.; average, $2.80 per lin. ft.; highest bid for 24-inch sewer, D. Looney, at $3.50 per lin. ft.; lowest, D. McNamara, at $1.64¾ per lin. ft.; average, $2.39 per lin. ft.; highest bid for 18-inch sewer, C. H. Eslin & Co., at $3.00 per lin ft.; lowest, S. Cook, at $1.10 per lin. ft.; average, $1.90 per lin. ft.; highest bid for 15-inch sewer, C. H. Eslin & Co., at $3.00 per lin. ft.; lowest, S. Cook, at $1.00: average, $1.53. The contract was awarded to H. Himber, for $1.81 per lin. ft. for 36-inch sewer, $1.72 per lin. ft. for 24-inch sewer, $1.77 per lin. ft. for 18-inch sewer, and $1.54 per lin. ft. for 15-inch sewer. W. J.

LAKE SHORE AND MICHIGAN SOUTHERN RAILROAD.

In speed, directness and safety, there is no railroad which surpasses the Lake Shore & Michigan Southern, and the traveler who values his time, his life and his comfort, will go by that company's route. From the care bestowed upon the track, the solidity of the work, the scientific grading, the class of rolling stock, the certainty of trains agreeing with the established timetables, the almost fastidious choice of none but the best of officers, the stringent rules as to the sobriety of conductors, engineers and all employees, and the superintendence of none but qualified men, the Lake Shore & Michigan Southern have been enabled to get an unequalled safety of travel. There is no line in America more worthy of public patronage. In Chicago the business of the road is in the hands of F. E. Moore, Esq., the General Passenger Agent at this point, and he is doubtless proud of having the superintendence of a line so thoroughly adapted to the wants of the traveling public.

Chillicothe, O., has definitely concluded upon erecting Water Works. The clerk has been instructed to advertise for proposals.

The Urbana, O. water works capital stock $100 000 in shares of $100 each have been incorporated by Henry Fox and others.

The Kentucky River Bridge on the Cincinnati Southern Railway, described on page 37 of our current volume has just been tested.

The work is being pushed on the Montreal, Portland & Boston Railway. It will be opened in June, and will form another through line from Montreal to Boston.

The monopoly of the use of the entire water power of Niagara Falls upon the American side of the river, with canal, etc., is to be sold at auction on May 1.

Another index of the nearness of good times comes from Lynn, Mass., where the shoe manufacturers are running on overtime. The business is one-third better than it was one year ago.

The chief of engineers reports in favor of expending over $1,000,000 of river and harbor appropriation, inciuding $25,000 for Hudson river, $14,000 for Burlington, Vt., $25,000 for Erie harbor and $20,000 for Oswego harbor.

Brown & Co., of the Wayne Iron and Steel Works, Pittsburgh, have recently receivedi nquiries from London and Berlin for the prices of their "U. S." iron plates. These inquiries are the result of the exhibition of this brand of iron at the Centennial Exhibition.

The survey for the branch road connecting Canton with the Massillon & Coshocton R. R., Ohio, by way of Navarre, and terminating at Justus, was completed lately, and a profile of the route is being made out by Mr. Cock, the engineer employed by the gentlemen who have the matter in hand. Mr. Cock pronounces the route much more desirable than he expected to find it.

Capt. Berthoud, says the Cheyenne *Leader*, has completed the survey of the extension of the Colorado Central from Longmont, Colo., to Cheyenne. Work will be begun at once and pushed to completion. The distance is less than 75 miles, the grade easy, and the road can be built at small cost. The road will pass through as good country as there is in the west for the first 50 miles from Longmont to Box Elder.

The Grand Trunk Railway Directorate, of Canada, proposes to introduce steel cars in which to carry grain. They are to be shorter than the present cars and as much stronger as steel is than wood, which will permit of the grain being loaded higher than at present. The new cars are to weigh six tons instead of ten tons as now, and carry eighteen tons instead of ten. Cars of the new model are being experimented with.

Several New York, City railroad officials visited Philadelphia lately for the purpose of examining the new steam street cars on the Market street road. They were received by President John S. Morton of the company, and Mr. Louis Ransom, of Troy, New York, patentee of one of the cars. After a thorough examination of the cars they agreed to prepare memorials to be submitted to the Legislature of New York asking the privilege of experimenting with them in New York city. The delegation included Messrs. Philips, of the Third Avenue Line; Peters and Fields, of the Sixth Avenue Company; Mr. Sullivan, of Brooklyn, and others.

Much success has attended the adoption of steam for moving street cars in Paris. Along the grandest boulevard in the city, and winding through some of its busiest streets, turning sharp angles and climbing and descending perceptible grades, the Merriweather engines draw crowded cars from Arc de Triomphe to the Bastile, a distance of seven miles, at a speed of eight miles an hour, and nobody is hurt, and even the horses see it pass with contemptuous disregard. The engine is noisless and smokeless. It has proved to be far more economical than horse power, and a large additional number have been ordered.

The report of the committee of experts on the engines of the Chicago West Side pumping works has been handed to the Mayor. The engines have exceeded their claims. They can raise 15,000,000 United States gallons of water in 24 hours, elevate the volume 155 feet, and develop a duty of 90,000,000 pounds of water raised one foot with 100 pounds of ordinary anthracite. The failure of the first test was declared due to the following facts: the coal was poor; the boiler was partly filled with deposit, resorting to the artificial draft of a steam jet. The engines acting independent of supplying the city, the supply was more uniform.

The Toledo Harbor Work's contract calls for the improvement of the natural channel through Maumee Bay, by widening it to not less than 250 feet on top and 200 feet on the bottom; the channel to be dredged so that there will be fifteen feet of water there at the lowest stage. In order to accomplish this end, 50,000 cubic feet of earth will be excavated, and the work is to progress at the rate of 400 cubic yards per day, until it is completed. This will make the channel from the lake to the docks one that will allow the largest vessels to enter safely, and will be wide enough to allow tows to pass each other, even at the elbows.—a feat that has heretofore been next to impossible. The work will be pushed forward rapidly to completion, and then Toledo will have a really first-class harbor. Messrs. William Richardson & Co., of Toledo, have secured the contract.

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 88.*)

50. As stated in § 46, the curves of equilibrium for a single load at successive points on half of the arch are shown in Fig. 10, and the other side would give a symmetrical figure. The ordinates $y-z$ cannot, of course, be scaled as closely as they can be computed. By calculating a set of values for M, as above, for a load on each point in succession, we can make a table which shall by inspection give the bending moments at all points of division for a load at any one; and, consequently, by adding the numerical factors, we can find the bending moment of any combination of loads, of any magnitudes, and can see what positions of the loads will cause the maxima positive and negative bending moments.

Such a table has been prepared, the span being divided into twenty parts, enough for the generality of cases. As a load on either side of the middle gives the same set of values in a reverse order, it is necessary to calculate but one half of the table. As many decimals may be taken as will give sufficiently accurate results.

PARABOLIC ARCH, HINGED AT ENDS. TABLE FOR M. $M = m\,c\,W$. VALUES OF m.

Point of Division.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	H
W on 1	+.0832	+.0676	+.0523	+.0402	+.0289	+.0178	+.0084	+.0003	−.0066	−.0122	−.0166	−.0197	−.0216	−.0222	−.0216	−.0195	−.0167	−.0124	−.0068	.0623
" 2	+.0607	+.1359	+.1051	+.0815	+.0580	+.0370	+.0184	+.0023	−.0226	−.0314	−.0365	−.0416	−.0430	−.0420	−.0385	−.0325	−.0241	−.0133	.1226	
" 3	+.0509	+.1051	+.1634	+.1250	+.0902	+.0590	+.0315	+.0075	−.0129	−.0297	−.0429	−.0525	−.0585	−.0609	−.0598	−.0550	−.0467	−.0347	−.0191	.1797
" 4	+.0359	+.0765	+.1217	+.1715	+.1260	+.0851	+.0450	+.0150	−.0007	−.0320	−.0497	−.0627	−.0711	−.0749	−.0740	−.0685	−.0583	−.0435	−.0241	.2320
" 5	+.0221	+.0498	+.0831	+.1219	+.1663	+.1162	+.0717	+.0328	−.0006	−.0283	−.0505	−.0672	−.0783	−.0838	−.0837	−.0781	−.0670	−.0502	−.0279	.2783
" 6	+.0097	+.0257	+.0480	+.0767	+.1116	+.1532	+.1016	+.0551	+.0155	−.0176	−.0445	−.0649	−.0791	−.0863	−.0832	−.0733	−.0720	−.0545	−.0304	.3176
" 7	+.0013	+.0130	+.0170	+.0366	+.0632	+.0968	+.1374	+.0849	+.0316	+.0010	−.0305	−.0551	−.0726	−.0852	−.0868	−.0786	−.0730	−.0556	−.0313	.3491
" 8	+.0107	+.0289	+.0480	+.0819	+.1210	+.0475	+.0815	+.1229	+.0717	+.0280	+.0083	−.0371	−.0586	−.0725	−.0790	−.0786	−.0697	−.0539	−.0307	.3720
" 9	+.0183	+.0492	+.0818	+.1270	+.0145	+.0058	+.0338	+.0695	+.1129	+.0641	+.0229	−.0105	−.0362	−.0547	−.0644	−.0670	−.0618	−.0439	−.0283	.3959
" 10	+.0242	+.0606	+.0492	+.0500	−.0430	+.0281	+.0055	+.0250	+.0633	+.1094	+.0641	+.0250	+.0055	−.0281	−.0430	−.0500	−.0492	−.0406	−.0242	.3906
" 11	+.0283	+.0489	+.0618	+.0670	−.0644	−.0542	−.0362	−.0105	+.0229	+.0641	+.1129	+.0695	+.0338	+.0058	−.0145	−.0270	−.0318	−.0289	−.0183	.3859
" 12	+.0307	+.0550	+.0697	+.0780	−.0790	−.0725	−.0585	−.0371	−.0083	+.0280	+.0717	+.1229	+.0815	+.0475	+.0210	+.0019	−.0097	−.0139	−.0107	.3720
" 13	+.0313	+.0545	+.0730	+.0834	−.0868	−.0832	−.0726	−.0551	−.0305	+.0010	+.0394	+.0849	+.1374	+.0968	+.0632	+.0366	+.0170	+.0130	+.0013	.3491
" 14	+.0304	+.0545	+.0720	+.0833	−.0882	−.0868	−.0791	−.0649	−.0445	−.0176	+.0176	+.0553	+.1016	+.1532	+.1116	+.0767	+.0480	+.0257	+.0097	.3176
" 15	+.0279	+.0502	+.0670	+.0781	−.0837	−.0838	−.0733	−.0627	−.0429	−.0207	−.0120	−.0097	−.0173	−.0328	−.0075	−.0023	−.0018	−.0008	−.0003	.2783
" 16	+.0241	+.0435	+.0583	+.0685	−.0740	−.0749	−.0711	−.0627	−.0497	−.0320	−.0207	−.0129	−.0075	−.0023	−.0018	−.0008	−.0003	.2320		
" 17	+.0191	+.0347	+.0467	+.0550	−.0593	−.0609	−.0585	−.0525	−.0429	−.0297	−.0207	−.0129	−.0075	−.0023	−.0018	−.0008	−.0003	.1797		
" 18	+.0133	+.0241	+.0325	+.0385	−.0480	−.0430	−.0416	−.0365	−.0314	−.0226	−.0129	−.0075	−.0023	−.0018	−.0008	−.0003	.1226			
" 19	+.0068	+.0124	+.0157	+.0198	−.0216	−.0222	−.0197	−.0166	−.0122	−.0066	−.0030	−.0008	−.0003	.0623						

By the use of logarithms the labor of preparing another table for a different number of divisions is very little.

Each column belongs to the point of division whose number stands at its top, the numbers commencing at the left abutment. Each horizontal line contains the factor for bending moment at each point of division for a load W on the point marked at the beginning of the line. The values of H are placed, for convenience, in the last column.

51. As it was proved, in § 34, that the parabola is the curve of equilibrium for a load distributed uniformly horizontally, when we place simultaneously on each one of the nineteen points a load W, this rib ought to be very nearly in equilibrium. By footing up the vertical columns we shall get no result which differs from zero by more than about .01 c W. The values of M calculated in § 49 will be found in alternate columns in lines 6 and 14; for we then supposed only ten divisions. This table will be referred to again.

52. In the solution of any particular example, it will often happen that the points at which the weight will be concentrated will not coincide with the points of division which we have taken. It will then be necessary to determine new values of y_0 and H, which may be done by the original formulæ or by interpolation. A new table of M may be calculated, values may be interpolated in the one given here, or, if preferred, from the value of H and the vertical components of the reactions we may draw a curve of equilibrium for any combination of loads. The table here given, if not directly applicable, subserves two purposes, one to show how a similar table can be made, and the other to indicate by inspection what arrangement of loads on any arch will produce the maxima stresses.

If the successive values of any quantity increase at a tolerably uniform rate, any intermediate value between two given ones may be put in by simple proportion. Otherwise we may use the formula for interpolation—

$$\text{Desired quantity} = a + f\left[\mathrm{D}_1 - \tfrac{1}{2}(1-f)\,\mathrm{D}_2\right]$$

in which a denotes the first given quantity, f the fraction of a division from a to the desired quantity, and D_1 and D_2 the *first* and *second differences*. To illustrate, take the values of H in § 46. If we place these in a column as below, find the amount of *increase* from quantity to quantity, and then subtract these differences from one another, marking each + if it is an increment, and *vice versa*, we obtain the columns of first and second differences as marked. Now suppose that we wish to determine a value of H at $b = .5\,c$; a will be .3176, $f = \frac{1}{2}$, $\mathrm{D}_1 = -.0856$, and D_2, for an average value between .0312 and .0238, $= -.0275$. If we substitute in the formula it then becomes

b.	H.	D_1.	D_2.
0	.3906		
		−.0186	
.2c	.3720		−.0358
		−.0544	
.4c	.3176		−.0312
		−.0856	
.6c	.2320		−.0238
		−.1094	
.8c	1226		

$$\text{H (for } .5c) = .3176 + \tfrac{1}{2}\left[-.0856 - \tfrac{1}{2}\cdot\tfrac{1}{2}\,(-.0275)\right]$$
$$= .3176 + \tfrac{1}{2}\,(-.0856 + .0069) = .2783\,.$$

This value will be seen to agree with the one given in the large table, found by the formula (12.) § 46. The factor for y_0, at ⅓ of the interval between .4 c and .6 c, would, in the same way, be

$$1.3223 + \tfrac{1}{3}\left[.0570 - \tfrac{1}{2}\cdot\tfrac{2}{3}\,(.0283)\right] = 1.3382.$$

Careful heed must be paid to the signs.

53. Having carried the investigation thus far, it may help to fix the ideas to draw a curve of equilibrium for some combination of weights. We shall take but a few loads, in order to have the diagram clear, but the reader may vary the example by taking other amounts in other places. One good construction would be a uniform load over one-half of the span. The curve of equilibrium for such a load, on the left half of the arch of Fig. 10, is represented in that figure. The values of the two vertical components of the abutment reactions will be the sums of the components for each load, and the amount of H for the whole load will be the sum of the separate H's. Lay off, therefore, on a vertical load line, the given weights in order, and, by taking moments or otherwise, determine and lay off the two vertical reactions, so that these external forces shall come in order down and up the line, as explained in § 32.

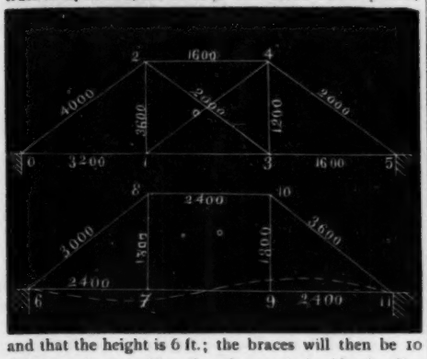
Multiply each numerical factor which belongs to H by the number of units of weight which are placed on the point to which the factor refers, add up the products and plot the resulting value of H horizontally from the point of division between the two vertical reactions. Lines connecting the points of division between the weights with the free extremity of H will be parallel to the respective sides of the curve of equilibrium. Since this curve begins at one springing, and passes round in the general direction of the arch to the other springing, we can at once see on which side of the vertical line to lay off H.

54. For example:—Let us draw the curve of equilibrium for an arch of 100 ft. span, 20 ft. rise, whose weight is at present for simplicity's sake neglected, and carrying weights of 3 tons, 2 tons, 4 tons and 2 tons, at the end of the 3d, 6th, 8th, and 9th, division from the left, of ten equal horizontal divisions, as shown in Fig. 11, where the numbers denote the weights and the points of division above mentioned. The supporting force on the left will be

(*To be continued.*)

THE TRAPEZOIDAL TRUSS WITHOUT COUNTERS.

The trusses which are here illustrated are often used for spanning moderate openings, the verticals being of iron and the remaining pieces of timber. We have thought it would not be uninteresting, to those of moderate acquaintance with the analysis of trusses, to consider what are the stresses on the several members under a given load, and more particularly to make a comparison of the two trusses under a partial load. To simplify calculations and avoid fractions let us suppose that each truss is 24 ft. in span, divided into three equal panels,



and that the height is 6 ft.; the braces will then be 10 ft. long. A supposition that the steady load is 1800 lbs. on each joint, and the travelling load 3600 lbs. per joint, will serve our purpose.

As the trapezoidal truss requires no counter-bracing under an equal load at each joint, the horizontal thrusts of the end braces balancing one another, a complete load of 5400 lbs. at each joint will cause the same stresses in either truss. The reaction at one abutment being 5400 lbs., the thrust on the brace will be $5400 \times \frac{10}{6} = 9000$ lbs., and its horizontal component, compression in the upper member, tension in the lower member, will be $5400 \times \frac{8}{6} = 7200$ lbs. The tension on either vertical rod will be 5400 lbs., and this force might as readily have been decomposed at the upper end of the vertical into the stresses on the top chord and the brace. The handiest rule, as it seems to us, when we have a force on one member, and desire to find the magnitude of its component along another member which meets the first one, is, to divide the given force by the length of the piece over which it came, and multiply by the length of the piece in which the stress is sought. The operation is equivalent to multiplying by the cosine, tangent or secant of an angle, as the case may be, and relieves one from the consideration of the particular function of the angle required.

If the counter-braced truss carries 3600 lbs. of travelling load at the left-hand joint only of the lower chord, and this lower chord is considered as possessing no stiffness at the joints, the loaded point 1 will tend to drop, carrying with it the joint 2; therefore, 4 will tend to rise, so that the diagonal 2-3 will be shortened, and we are obliged to insert the timber strut 2-3 to keep the truss in shape. Of the 3600 lbs. at 1, two-thirds will be supported at 0 and one-third at 5. The thrust on 0-2 will then be $2400 \times \frac{10}{6} = 4000$ lbs.; the tension on $0\text{-}1 = 2400 \times \frac{8}{6} = 3200$ lbs.; the thrust in 4-5, from the reaction at 5 must be 2000 lbs.; or one-half that in 0-2; the tension in 3-5 = 1600 lbs. = compression in 2-4; 2-3 carries the same one-third of the weight which goes to 5, and its compression is therefore 2000 lbs., as in 4-5, while its horizontal component along 3-0 will be 1600 lbs.; the tension in 1-2 is 3600 lbs., and in 3-4, 1200 lbs. It is manifest therefore that the horizontal component of the thrust of 0-2 is balanced by those of 2-3 and 4-5 combined, 2-3 resisting what it can, and the remainder acting through 2-4 and 3-5. Of course 1-4 is inactive until the load shifts to 3. These stresses are placed on the sketch.

If 3600 lbs. is placed at 7 on the other truss there will be a similar tendency towards deformation of the middle panel, and this tendency must be resisted by the stiffness of the beam used for the lower member. This piece must therefore be continuous from 6 to 11. When 7 is slightly depressed the tension on 7-8 carries 8 down also. Then 10 must rise, for the pieces 6-8, 8-10, and 10-11, being held at 6 and 11, make a sort of balance beam, the piece 8-10 turning about its centre. As 10 rises, it causes, by tension on 10-9, a bending upwards of the lower member at 9, so that the lower chord tends to assume the form shown by the dotted line. As the vertical force at 10 must equal that at 8, and as the bending of the beam upwards at 9 must be the same in amount as the bending downwards at 7, it is evident that one-half of W, or ½ of 3600 lbs., is carried by the beam at 7 *as a beam;* that the other ½ W is carried by the vertical rod 7-8; and that an equal upward force, required to balance it at 10, will, by tension of ½ W on 9-10, bend the lower chord upwards at 9.

The stresses on this truss will be, therefore, 1800 lbs. tension on 7-8 and 9-10, $1800 \times \frac{10}{6} = 3000$ lbs. compression on 6-8 and 10-11, and $1800 \times \frac{8}{6} = 2100$ lbs. compression on 8-10, and tension on 6-11. From the pieces 6-8 and 10-11 we get a reaction or supporting force of 1800 lbs, on each of the abutments. The member 6-11 acts as a beam under a weight of 1800 lbs, at 7 and an equal but upward force at 9. A point of contraflexure will therefore exist midway between 7 and 9, so that the beam may be treated one of twelve feet span carrying a load of 1800 lbs. at eight feet from the abutment. The necessary supporting force at 6 will then be ⅓ of 1800 lbs. or 600 lbs., which, added to 1800 lbs, the vertical component of 6-8, gives 2400 lbs., total reaction as required for a weight of 3600 lbs. at 7. Likewise at 11 we have an upward force of 600 lbs. from the pull of the rod 9-10, and the total supporting force at this abutment will be 1800 — 600 = 1200 lbs.

The bending moment will be a maximum at the point of application of the force, and its magnitude will be found by multiplying the amount of weight carried by the beam to the abutment by the distance 6-7 or 9-11; the moment therefore is $600 \times 8 = 4800$ ft. lbs., which must be resisted by the section of the lower chord at 7 and 9. As at the point of contra-flexure in mid span one part of the beam carries the other, the shear there will be 1200 lbs. The piece 6-11 must also resist at the same time the tension due to the steady load and a travelling load on one joint, or 4800 lbs.

It is apparent that, in this example, a full load causes greater direct stresses in the pieces than does a partial load, but with a light steady load and heavy travelling load such may not be the case. As 6-11 is generally made a continuous timber we may avail ourselves understandingly of its stiffness, if we please, and leave out the counterbraces.

TRANSMISSION OF POWER BY ELECTRICITY.

At the eighth annual meeting of the Iron and Steel Institute, at London, March 20 to 22, the inaugural address was delivered by Dr. Siemens. After speaking at some length upon the importance of an enlightened superintendence and direction of metallurgical works, of obtaining labor upon reasonable terms, and of cheap fuel, for success in the production of iron and steel, he throws out some suggestions as to possible utilizations of power now allowed to go to waste which we have thought it expedient to reproduce. He said "the introduction of the steam engine, towards the end of the last century, changed the industrial aspect of the world in causing manufactories to be massed together in great centres, and this tendency has been still further augmented in consequence of the construction of canals and railways, which enable us to bring together the raw material and to disperse the manufactured product at a comparatively low cost. It is not unreasonable, however, to expect that a certain reaction in this process of centralization will gradually take place, because, in consequence of ever increasing competition, the advantage of utilizing natural forces, which we could afford to neglect during a period of general prosperity, becomes again an essential element in determining the very lowest price at which our produce may be sent into the market. The advantage of utilizing water-power applies, however, chiefly to Continental countries, with large elevated plateaus, such as Sweden and the United States of North America, and it is interesting to contemplate the magnitude of power which is now for the most part lost, but which may be, sooner or later, called into requisition.

"Take the Falls of Niagara as a familiar example. The amount of water passing over this fall has been estimated at 100 millions of tons per hour, and its perpendicular descent may be taken at 150 feet, without counting the rapids, which represent a further fall of 150 feet, making a total of 300 feet between lake and lake. But the force represented by the principal fall alone amounts to 16,800,000 horse-power, an amount which, if it had to be produced by steam, would necessitate an expenditure of not less than 266,000,000 tons of coal per annum, taking the consumption of coal at 4 lbs. per horse-power per hour. In other words, all the coal raised throughout the world would barely suffice to produce the amount of power that continually runs to waste at this one great fall. It would not be difficult, indeed, to realize a large proportion of the power so wasted, by means of turbines and water-wheels erected on the shores of the deep river below the falls, supplying them from canals cut along the edges. But it would be impossible to utilize the power on the spot, the district being devoid of mineral wealth or other natural inducements for the establishment of factories. In order practically to render available the force of falling water at this, and the thousands of other places under analogous conditions, we must devise a practicable means of carrying the power to a distance. Sir William Armstrong has taught us how to carry and utilize water-power at a distance, if conveyed through high-pressure mains, and at Schaffhausen, in Switzerland, as well as some other places on the Continent, it is conveyed by means of quick-working steel ropes passing over large pullies. By these means, power may be carried to a distance of one or two miles without difficulty. Time will probably reveal to us effectual means of carrying power to great distances, but I cannot refrain from alluding to one which is, in my opinion, worthy of consideration, namely, the electrical conductor. Suppose water-power to be employed to give motion to a dynamo-electrical machine, a very powerful electrical current is the result. This may be carried to a great distance, through a large metallic conductor, and there be made to impart motion to electro-magnetic engines, to ignite the carbon points of electric lamps, or to effect the separation of metals from their combinations. A copper rod of 3 in. in diameter would be capable of transmitting 1,000 horse-power a distance of say 30 miles, an amount sufficient to supply 250,000 candle power, which would suffice to illuminate a moderately sized town. The use of electrical power has sometimes been suggested as a substitute for steam power, but it should be borne in mind that so long as the electric power depends upon a galvanic battery, it must be much more costly than steam power, inasmuch as the combustible consumed in the battery is zinc, a substance necessarily much more expensive than coal; but this question assumes a totally different aspect if in the production of the electric current a natural force is used which could not otherwise be rendered available."

There does not seem to be anything impracticable in Dr. Siemen's suggestion that the work of a water power may be converted into electricity, conveyed to a distance by a suitable conductor, and then reconverted to give motion to machinery. Whether the time will soon come when it will be thought expedient to inaugurate such an enterprise is another question. It is but a short time since dynamo-electrical machines have been so developed as to render such a step possible, but they can now be constructed of any desired power. The Gramme Machine may be built for about one hundred dollars per horse power, a not unfavorable comparison with a steam engine, and it is a good example of a reversible engine, that is one which may be worked either way. If mechanical power is applied to the machine it is converted into electricity, while when a current is passed through the coil, it is converted into motion.

The change of energy from one form to another in this way is, however, practically attended with considerable loss of work, and such a series of steps, from the original source of power to the distant place where local circumstances make it desirable to establish the factory, would only be profitable, if at all, where the power was cheap and could not be utilized otherwise. In the case of a water power, the force of the water must first be brought upon a wheel, which may be made to develop from 75 per cent. to 80 per cent. of the energy of the water which passes through it. The Gramme machine will convert some 90 per cent. of the power applied to it into electricity. Two of these machines have been con-

nected by a short circuit, and it has been found that the second machine will give out 50 per cent. of the mechanical work applied to the first.

Then we have the additional loss from the resistance of the long conductor, which resistance enters into a formula as a divisor; that is, if C represents the current, E the electro-motive force and R the resistance, $C = E \div R$. The resistance varies as the length of the conductor and inversely as the cross-section. It will be seen to affect the available power much as friction in a water-pipe lowers the dynamic head, or wire drawing diminishes the effective pressure of steam. If the product of these various ratios seems to give a very small percentage of the original power finally obtained, we have only to consider how little of the calorific power in coal we succeed in converting into work in our best steam engines, to make it appear not so bad a result after all.

This idea of the conveyance of power to a distance by means of electricity has been broached before, and some have thought that by a ramification of wires through a city, they might deliver power at small manufactories wherever desired. The difficulty in such an application of the idea to practice is, that the electric current will take the path of least resistance; that machine most favorably situated would feel the larger part of the force, would be driven at too great a speed, and then the connections would be melted and burned off by the intensity of the stream. Electricity cannot be distributed like water and gas.

ANOTHER PLAN FOR IMPROVING NIAGARA.

By a somewhat curious coincidence another gentleman has turned his thoughts towards making the mighty cataract of Niagara useful to man. The *Ottawa Free Press* contains the following:—

"A letter has recently been addressed to his Excellency the Governor General, by Mr. Horace H. Day, a gentleman who owns the American side of Niagara Falls, on which side the water-power much exceeds that of the Canadian fall. Mr. Day recommends the utilization of the vast water-power by the establishment there of manufactories for spinning and weaving cotton cloth. When our ship canals, and eventually the Pacific Railway, are completed, the subject of cheap production may have a measure of interest to our manufacturers not now even thought of. The chief points of Mr. Day's scheme are the following; and should his ideas as yet fail to be appreciated, we may call to mind Geo. Stephenson, fighting his railway enterprise through amid the ridicule of parliament and people, and Mr. Muntz going humbly from one ship owner of London to another, vainly asking permission to apply, at his own expense, a coat of his metal to the bottoms of their ships:

1. The formation of compressed air, by means of the water-power, and its appliance to drive the machinery of cotton factories, placed where convenient, the air being conveyed in pipes and applied to the common steam-engine.

2. The manufacture, by this means, of cotton cloth, so near to the producing points of the raw cotton and of the food staples as materially to lessen the cost of production.

3. The loading and unloading of vessels by means of the same cheap hydraulic power, the only expense of which is, of course, the erection of the apparatus.

4. The gray cotton cloth being so manufactured, its transportation (when the canals are enlarged) in seagoing vessels, direct from the point of production to England, there to undergo the finishing process of bleaching and printing, and to be thence distributed to the markets of the world.

We understand that his Excellency has promised Mr. Day to lay his communication before the Dominion government, and to forward a copy of it to the Secretary of State for the colonies, for the consideration of her Majesty's government."

If we mistake not, this gentleman has for a number of years been interested in the projects for the transmission of power by means of compressed air. Apparatus for this purpose was on exhibition several years ago at Portland, Maine, and the experiment was successfully tried on a small scale in the neighboring town of Brunswick. At that place an air compressor was driven by a turbine, and the compressed air, after being cooled by water, was distributed through the streets by pipes laid in the ground. A few small engines were run by this means, but there was not enough business done to make the venture profitable. The loss of pressure was said to be very slight in going a mile, and we could see no reason why small powers might not in this way be distributed to users and the project be remunerative, where water power was accessible and cheap.

THE citizens of Detroit, Michigan, are discussing with renewed interest the proposition to aid in the construction of a tunnel under the river at that point. They begin to feel that, unless definite steps are taken by them soon to encourage its location there, a crossing will be made elsewhere and the prosperity of the city will receive a serious shock. The proposition which is now strongly urged contemplates giving $500,000 outright, as a *bonus*, to parties who will construct a tunnel for the use of the railroads; the estimated cost is between $2,500,000 and $3,000,000.

THE notification of the Philadelphia & Reading Railroad Company to their locomotive engineers that they must choose between working for that company and continuing members of the Brotherhood was followed by the withdrawal of some two hundred and fifty engineers from the company's service. Their places have been supplied and business has been but little hindered. This action of the Philadelphia & Reading Company, rendered necessary, as it was thought, by the recent strike on other roads, must have dealt a severe blow to the engineer's organization.

DR. SIEMENS in his recent address does not advocate any attempt at comprising in the curriculum of technical schools a practical working of the processes which the student would have to conduct in after-life. He says that "the practice taught in such establishments is devoid of the commercial element, and must of necessity be an objectionable practice, engendering conceit in the mind of the student, which will stand in the way of the unbiassed application of his mind to real work. Let technical schools confine themselves to the teaching of those natural sciences which bear upon practice, but let practice itself be taught in the workshop and in the metallurgical works."

The Cleveland *Trade Review* says: "The Globe Iron Works was lately awarded a contract for a copper boiler, eighty feet long and six feet in diameter, with a spherical head, the material used to be pure copper, five-eighths of an inch in thickness, and costing about $17,000. The boiler will be used in impregnating timbers for shipbuilding, docking and piling by the Thilmany process, which has been adopted by the general government."

This process as described in a pamphlet issued by the proprietors of the patent, consists of the introduction of Sulphate of Copper under pressure, followed or preceded by Chloride of Barytes, when there takes place in the wood a chemical reaction, an insoluble Sulphate of Barytes and a Chloride of Copper being formed.

THE PUBLIC WORKS OF INDIA.*

Before the Roman invaders had commenced the lines of communication and of defense that gave form to the subsequent local divisions of England, the Indian Rajahs were at work in storing the copious rainfall that descended on the mountain ranges of their country, and in providing the means of irrigation that should turn desert into garden. In various parts of India exist numerous old native works, many of which bear witness to great engineering skill, exercised at a remote antiquity. The most important of these are in the southern part of the peninsula, where innumerable tanks, containing from a hundred million of cubic yards of water downwards, store supplies for the summer maintenance of the flow of the great river channels. Many of these noble works have stood for centuries. Many of the weirs that bridle the discharge of rivers are built on sandy foundations, without any rock or sound stratum on which to base them, and yet have been constructed with such art as to modify the practice of our own engineers. Our latest modes of sinking the foundations of river bridges by means of iron cylinders, has been anticipated at a date of unknown antiquity, by the simple contrivance of wells or shafts lined with bricks, built on the surface, and sunk to the required depth by workmen who undercut the sides of the shaft, and thus facilitated the gradual descent of the brick tube. Till within the last thirty years very little has been done by the Indian government even for keeping these important works in repair. When Sir Arthur Cotton was ordered to report on irrigation works in 1836, he found many thousand tanks in every state of disrepair or ruin, scarcely any in good repair, and not one of British construction. Over the greater part of India are found patches of land irrigated by hand, or by the aid of bullocks, raising water from wells, rivers, or lagoons. The *ne plus ultra* of simplicity, and, indeed, the most effective application of human labor was attained by the contrivance called a *picottah*, which is as old as anything with which we are acquainted in India. The cost of raising water by this contrivance, which is about the same as the cost by the use of bullocks, to a height of from twelve to fifteen feet, is calculated at about 3,000 cubic yards to the pound sterling.

The Nizam's territory, Mysore, and the Carnatic, are covered with thousands of tanks. In the fourteen districts of Madras, according to Mr. Markham's statement, there are said to be 43,000, all of native origin, with probably 30,000 miles of embankments, and 300,000 separate masonry works. The revenue dependent on tanks was £1,500,000 per annum; yet in 1853 not one new tank had been made in Madras by the English, although many had been allowed to fall into disrepair. The area of the province of Madras is 139,698 square miles. The population in 1871 was 31,597,872 souls. In Mysore, until quite recently, the maintenance of the ancient tanks was far from satisfactory. The mode of formation of these reservoirs differs according to the features of the country, and the most remarkable tanks may be described as cases in which man has so far availed himself of the provisions of nature, as to form large artificial lakes by barring the exit of a stream from a mountain valley. In some cases descending terraces of land are occupied by a succession of reservoirs; the upper filling first from the rains, and the surplus water gradually filling the series as they descend the slope. In other instances long slopes are embanked on three sides, the included space forming a storage area for a supply of water adequate to the local demand. Some tanks of this description are of great antiquity. The Veranum tank in South Arcot is still in full operation after an existence of fabulous duration. It is named after a famous rajah, its constructor. It has an area of thirty-five square miles, and is confined in the lower part by a *bund*, or embankment, twelve miles long, and about twenty feet high. It will contain one hundred million cubic yards of water, and it secures an annual revenue of £11,450. In 1827, when Sir Arthur Cotton was ordered to inspect it, he found it in utter disrepair, and the people dependent on its supply, were nearly in a state of rebellion from its neglect. The canal from the Coleroon, twelve miles long, by which the tank is fed for six months out of the year, had been allowed to fill up to the depth of six feet, so that it had only two feet of water flowing through it, instead of eight. The estimate of £3,500 for immediate repairs for a work of this extreme importance was rejected by the government of Madras; and it was not until 1833, when the discontent of the people had reached such a pitch that it was feared it would be necessary to send troops into the district, that substantial repairs were effected.

The Chembumbankum tank, in Chengalpat, looks like a picturesque natural lake. The embankment is more than three miles long, and the tank supplies water for the irrigation of nearly 10,000 acres of rice cultivation. Its safety during floods, is secured by six waste weirs (called *calingulas*), which give a total width of 676 feet of esape channel; a width which is within twenty feet of that of the open water-way of the Thames under London bridge. The supply is merely from rainfall and local drainage. An enlargement of this fine tank, at a cost of £11,000, was sanctioned in 1867, and the excavation and earthwork were completed in 1873. The Kaveripank tank, in North Arcot (we may mention that almost every writer uses a different spelling of his own) is also of great antiquity. It is fed from the Pallair river, and has an embankment nearly four miles long, revetted along its entire length with stone. It irrigates nearly 7,700 acres. In 1872 the water rose higher within it than had been the case for many years, and several serious slips in the ground occurred in consequence.

In Mysore there are few very large tanks, owing to the undulating nature of the country, and the irrigation of the district depends either on the Cauveri and its tributaries, or on numerous chains of small tanks. In

* From the British Quarterly for April.

these the process of silting up is continually going on, and constant inspection and repairs is requisite. During 1872–73 as many as 249 tanks were breached in this province. By the tank restoration scheme now in force the irrigation department annually selects a certain number of tanks for immediate repair, brings them up to a certain standard, and then leaves them to be kept in repair by the ryots, under the directions of the revenue officers. In this way all the tanks of the province are being gradually dealt with.

In the Bombay Presidency the Ekruk tank is situated on the Adela, a tributary of the Blaina, four miles north of the town of Sholapur. A dam of earthwork, with masonry flanking is thrown across the valley drained by the stream. This embankment is 7,200 feet long, and attains in the deepest part the formidable height of 72 feet. A lake has thus been formed with an area of six and a half square miles, the filling of which submerged five villages, two of which were in the territory of the Nizam. The area watered by three channels leading from this tank amounts to 35,840 acres. The water was supplied free of charge in the year 18,2–73, being the first year after the partial completion of the works.

In Rajputana exist the noble tanks known as Lake Rajsumund and Lake Jeysumund. The former is twenty-five miles north of the capital, Oodipur, and is situated on the declivity of the plain, about two miles from the base of the Araoulli range. The *bund* or dam forms an irregular segment of a circle, nearly three miles in length, encircling the water except on the north-east and north-west edges of the lake. It is entirely faced with white marble, sustained by an enormous embankment, which it was the design of Raja Raj Sing, who constructed the work, towards the end of the seventeenth century, to plant with trees. A flight of marble steps leads down from the *bund*, which supports a temple built in honor of Kankeraoli, one of the seven forms of Krishna. The temple is ornamented with sculpture, and contains the pedigree of the founders family, inscribed in conspicuous characters. The work was named after its designer, Raj Sumund, or royal sea, and cost £1,150,000. Lake Jey Sumund, the Sea of Victory, was constructed by Jey Sing, the successor of Raj Sing, and is said by Mr. Tod to be the largest lake in India. Its circumference is stated to be not less than thirty miles. A perennial stream, flowing from the mountains, had formed a lake called the Dheybur Pool. Jey Sing threw a dam across a break in the mountains, between two natural buttresses of rock, and then created this little inland sea. On the *bund* was erected a palace for his favorite queen, who bore the name of Comala-devir. This lake supplies water for the irrigation of a large area of rice-growing land.

The irrigation works of India comprise three different classes of works, the applicability of either of which to the wants of a district depends on the physical conformation of the country and on the rainfall. In the mountainous districts, where the rainfall is often enormous, are constructed those great works for the storage and gradual distribution of the supply, of some of which we have given particulars. At the heads of the great river deltas, on the other hand, are constructed weirs, or *annicuts*, by means of which the volume of the river is headed back, in the dry season, to a height sufficient to allow of the distribution of its waters by canals over the area of the delta. Intermediate between these most land-ward and most sea-ward works directly constructed for the facilitation of irrigation, are to be found various kinds of canals, those of derivation, of diversion, and of distribution; many if not most of which are also adapted for purposes of navigation, and may thus most properly be regarded as a portion of the communications of the country, and referred to when we have spoken of the more important question of the facilities afforded to our military and civil administration, as well as to the commercial intercourse between various cities and districts, afforded by the railways.

The annual rainfall of India has been made a subject of systematic study. In Southern India Major-General Richard Strachy and Dr. Brandis, and in the northern districts Mr. Blanford, have laid down lines of equal average annual rainfalls, which map out the peninsula in parallel zones. In the northwest exists an arid region, including Sind and half the Punjab, where the nominal annual rainfall is less than fifteen inches. Here irrigation is essential to the existence of the population. Around this arid region exists a belt of country varying from 100 to 200 miles in width, which includes Delhi and Agra, and has been named by Dr. Brandis the Northern Dry Zone. The annual rainfall in this district is from fifteen to thirty inches. A similar district, called the Southern Dry Zone, covers the centre of the southern part of the peninsula, extending from Nasik to Cape Comorin, with an extreme breadth of about 190 miles. Irrigation is an absolute necessity in these dry zones. A fourth region, with a rainfall of between thirty and sixty inches, includes the upper part of the valley of the Ganges, Central India, and the eastern coast of the Madras Presidency. This also much depends on irrigation. The fifth region, comprising the deltas of the Mahanadi and of the Ganges, and the lower part of the Ganges valley, has a rainfall of between sixty and seventy-five inches. In this favored zone of country irrigation is no longer absolutely necessary for the cultivator, except in years of unusual drought; but the power of regulating the supply of water, by irrigation and by drainage, is an element of agricultural wealth in every district. In some it is absolutely indispensable; in all it is of inappreciable value. The two remaining regions are the zones of excessive rainfall; one extending from the mouth of the Irawadi, along the east coast of the Bay of Bengal, up the valley of the Bramahputra, and along the skirts of the Himalayas; the other along the west coast of the Peninsula, from the sea shore to the summits of the Ghauts. These zones are divided on the rainfall maps of India into two sub-zones, in the drier of which the annual rainfall is from seventy to one hundred inches, while in the wetter it exceeds one hundred inches. The care of the engineer in these districts is required to insure the safe and gradual discharge of the abundant supply of water, rather than for any other hydraulic purpose.

The magnitude of the natural features which map out the physical geography of India, and prescribe the natural limits for the work of the engineer, is so vast as to be oppressive to the imagination. The united areas of the basin of the Ganges and Bramahputra, which rivers, draining the southern and northern slopes of the Himalayas, unite in the enormous delta formed by their confluent streams, amount to a total of 762,000 English square miles. The length of the main stream of the Ganges is 1,514 miles, that of the Bramahputra 1,800 miles. The basin of the Indus, the course of which is also 1,800 miles long, covering 372,000 square miles, was the abode of the first civilized race in India, and is the region where irrigation was first practized in that country. The Godaveri has a course of 898 miles, and drains about one-tenth of the area of India, its basin being computed to cover 112,000 square English miles. Rising in the fourth of the rainfall zones, in the high country of Central India, it is fed by an average rainfall, according to Sir Arthur Cotton, of forty inches, and pours two hundred milliards of cubic yards of water annually into the bay of Bengal. At the end of the dry season its hourly discharge is about 300,000 cubic yards of water. But in extreme floods it rises thirty-one feet in vertical height at the apex of its delta, and then carries down 180 millions of cubic yards in an hour, a discharge which, if kept up for a month, would be equal to six times the October flow of the Nile, at the season when that river is at its height. The length of the course and area of the basin of the Irawadi are intermediate between those of the Indus and of the Godaveri, being respectively 1,060 statute miles, and 150,800 square miles. The Krishna, the geological delta of which joins that of the Godaveri, has a course of 800 miles, and drains a watershed basin of 95,500 square miles. The length of the Mahanadi, the delta of which river forms a sensible protuberance on the long line of coast reaching from the mouths of the Godaveri to those of the Ganges, is 520 miles, and the basin covers an area of 43,800 square miles. Taken altogether, the basins of the rivers that discharge their waters into the Bay of Bengal form an aggregate of 1,441,900 square miles; while those of the rivers that enter the Arabian Sea amount to 629,900 square miles. The difference between the data of physical and political geography is illustrated by the comparison of the hydrographic area of 2,071,500 miles thus composed, with the 943,406 square miles which form the total area of the twelve provinces which constitute British India. The aggregate length of the twenty-four principal rivers of British India, according to the map contained in the Report of the Moral and Material Progress and Condition of India during the years 1872–73, is 14,238 miles. The importance of the responsibility that weighs on the government engineers may be illustrated by the remark that a careful watch over this main channel system of 14,000 miles forms but a small part of the duty of those who are looked to, not only to maintain, but to improve the drainage, the irrigation, and the internal water communication of this vast empire.

To be continued.

CO-ORDINATE SURVEYING.*

BY HENRY F. WALLING, C. E.

Continued from page 102.

Outside of cities and larger towns, the instruments usually employed in surveying are the chain and compass. The method is to perambulate the boundary line of the tract to be surveyed, taking the magnetic bearings with the compass, and measuring with the chain the lengths of each side of the polygon forming the boundary.

IMPERFECTION OF THE COMPASS.

Now, provided the bearings thus taken were precisely measured angles from fixed parallel meridians, whose directions could always be easily ascertained, when a re-survey should be needed, no better method of noting directions could be desired. But this is far from being true. The magnetic force to which the direction assumed by the needle is due, is quite irregular in its action, changing its direction continually, backwards and forwards, even during the different hours of the day, while larger oscillations extending sometimes to many degrees of arc take place in irregular cycles, perhaps one or two centuries in duration. And this is not all. In regions containing metallic deposits, especially magnetic iron ore, very irregular and powerful local disturbances of the magnetic force arise, causing the needle to take widely different directions, even at points in close proximity to each other, thus destroying parallelism of action, and rendering the compass quite useless for ascertaining true directions.

Beside the uncertainty of the magnetic meridian, there is an incapacity of precision in the use of the compass for measuring angles. The needle must swing clear of the graduated limb, and cannot be suspended for field use, with very great delicacy. In practice it is usually imposible to read a magnetic bearing with greater precision than to the nearest 10 minutes of arc.

THEODOLITE AND SURVEYOR'S TRANSIT.

The theodolite and the surveyor's transit are instruments of far greater precision and are generally used in cities, and for more valuable farm lands, also for engineering works, roads, railroads, etc. Those in ordinary use, measure angles to single minutes.

In land surveying, the common method of using these instruments is to measure the angles formed by the sides of the bounding polygon with each other, and sometimes, for verification, with one or more diagonals. The compass needle, usually attached, affords an approximate means of ascertaining azimuths, but with no more precision than with the ordinary compass. It is accordingly, quite as difficult to retrace obliterated boundaries with these instruments as with the compass, unless one or more well-defined lines remain for reference.

SOLAR COMPASS.

The solar compass now used in the surveys of the public lands at the West, for running out the parallel and range lines is a great improvement upon the magnetic compass in the accuracy of its azimuths if not in the precision of reading minute angles. The direction of the sun, with proper adjustment of the instrument for the latitude of the place and declination of the sun and hour of the day, affords of course, a reliable means of obtaining the true azimuth of an observed line with as much precision as the mechanical construction of the instrument permits. The use of the solar compass, however, is limited to sunshining or slightly cloudy days, the middle portions of which, moreover, are unfavorable to accurate observations, and at best, the precision of

* From the Transactions of the American Society of Civil Engineers.

its angular measurements is much inferior to that attainable with the transit. Nevertheless, with the preliminary surveys of wild lands, where no trigonometrical survey has been made, and where rapidity and economy are required, as in the government surveys of western lands, it is a very convenient and useful instrument.

MEASUREMENT OF DISTANCES.

The direct measurement of distances is attended with even more difficulty than that of the determination of directions. It is accomplished by the repeated application of the chain, tape or measuring rod, as nearly as possible, upon the line to be measured. Passing over inaccuracies in the length of the measuring standard arising from imperfections of construction, inequalities or temperature, changes of length by stretching, kinking, etc., the difficulties of making the direct applications are frequently quite serious. It often happens that access to all parts of the line to be measured is difficult, if not impossible. In fact, the boundaries of improved properties are generally indicated by walls, fences, hedges, ditches, etc., which occupy a considerable width upon the ground, being partly upon either side of the dividing line, upon which it therefore becomes impossible to apply the measuring standard. In such cases, it is usual to measure the opposite sides of an imaginary parallelogram, equal offsets being made at the ends of the line, and the measurements effected between the offset points. The offset angles are quite frequently estimated by the eye, and brought as nearly as possible to right angles. Even if these angles are instrumentally measured, the operation becomes complicated, thus increasing the liability to error. Impassable obstacles along boundary lines are of frequent occurence, and various expedients, more or less complicated, are resorted to for ascertrining the distances through them. The difficulties of measuring accurately over uneven ground, requiring a careful and laborious use of the plumb line, the avoidance of sagging or unequal stretching when the chain is used, the exact marking on the ground of the end of the measuring standard, etc., are familiar to all land surveyors.

MEASUREMENTS OF ANGLES.

It is easy to see that measurements of angles with good instruments can be performed with far greater ease and precision than the measurements of distances by the ordinary methods. Either mode of measurement is merely a determination of *ratios*. Thus, when we measure the length of a line by direct application of a standard length upon the ground, we simply ascertain the ratio between the length of the measured line and that of the chain. So, if we measure the three angles of a triangle, we know by a simple computation, the ratio of its three sides to each other. The percentage of error in the ratios, as found by either method, is much less in the measurement of angles with good instruments; for although the distances which are compared together in this measurement, namely those marked in degrees along the limb of the instrument used, are many times smaller than those compared together in the measurement of distances upon the ground, the nicety of the mechanism and the ease of the verification by repetition admit a precision quite unattainable in actual ground measurements, except by slow and laborious processes.

TRIGONOMETRICAL SURVEY.

In the trigonometrical survey, this superiority of angle measurement is practically recognized. Convenient points are selected, at suitable distances from each other, where the angles between imaginary lines, joining adjacent points can be measured. The whole area to be surveyed is cut up by these lines into a network of triangles, and the ratios of the sides of these triangles to each other are determined by measuring the angles between them. Then, when we ascertain the length of any one side of any one triangle, we can compute all the sides of every triangle, or the distances from point to point throughout the whole survey.

DEGREE OF ACCURACY ATTAINED.

The accuracy of the result, accordingly, depends upon the precision with which this one side or base line is measured, as well as upon the accuracy of the angle measurements. It is usual to verify the whole of the work by measuring another base line in a distant part of the network of triangles. For example, in the Coast Survey work, a base line was measured at Fire Island, on the south side of Long Island, in 1834; another in Attleborough and Sharon, Massachusetts, in 1844; and another near the village of Epping, in Columbia, Washington county, Maine, in 1857. The distance between the Fire Island and Massachusetts bases, along the axis of triangulation, was 230 miles, and between the Massachusetts and Epping bases 295 miles. The length of the Fire Island base, 8715.942 metres, or 5.415 miles, as actually measured, varies from the length, as computed from either of the other two bases, by less than 0.07 metres, or 2.75 inches; and the probable error of any computed line between these two bases is shown by careful analysis not to exceed 1-288,000 of its entire length. This proportion of error to distance amounts to 0.22 inches in a mile, or a little less than 2 feet in 100 miles.

This degree of accuracy indicates the wonderful skill which has been attained in the construction and use of instruments both for the measurement of base lines and of angles. Thus, if we compare the actual distance upon the limb of a theodolite, 30 inches in diameter, which corresponds to an error of 1-288,000, which we will suppose to be all thrown into one of the three angles of a single well conditioned or nearly equilateral triangle, we shall find it equivalent to about 1-20,000 of an inch,* being about 0.71 seconds of arc.

The percentage of error here developed is so small that it would not practically vitiate the measurement of lands even in the most valuable localities of great cities.

SUPERIORITY OF THE TRIGONOMETRICAL METHOD.

The degree of precision commonly attained in direct measurements of distances by ordinary methods falls very far short of this, and even of that attainable in angle measurements with the ordinary surveyor's theodolite or transit.

It follows that accuracy, even in common surveying, would be promoted by using the method of triangulation for ascertaining ratios, whenever practicable or convenient, in preference to the common methods of traverse surveying. In the survey of a field, or tract of land, for example, triangulation from one or two judiciously selected and carefully measured bases would give the positions of the corners and other objects with greater accuracy and far less labor than the usual routine of perambulating the outside boundaries, which is now taught in treatises on surveying and generally practiced by surveyors.

ADVANTAGES OF COMBINING SURVEYING WITH GEODESY.

With the facilities afforded by the Coast Survey triangulations, when carried to the tertiary stage, it is not difficult to perceive that a general method of determining the positions of points by co-ordinates might be established, and that while determinations thus made would be far more satisfactory and definite than those obtained by the ordinary methods of surveying, they would involve no more labor. Under such a system, the field work might consist of such a combination of triangulation and traverse surveying as would be found most convenient under the special circumstances.

To carry out such a system, the trigonometrical stations should be located so near together that two or more of them would be available for any subsequent local survey. If not otherwise visible, there should be convenient arrangements for the temporary erection of signals upon stations to indicate their positions, making them visible from adjacent stations.

TRANSFORMATION OF CO-ORDINATES.

While for geographical purposes, the great co-ordinate planes already described are the most suitable for reference, simplicity and convenience would be promoted by transforming this general co-ordinate system into numerous plane rectangular systems of a point by giving its terrestrial latitude and longitude, we would give its "latitude and departure." or its co-ordinates, from the zero point or origin of co-ordinates for the containing area.

For this purpose the local areas, into which the earth's surface is subdivided, should be made sufficiently small to reduce the error which would arise from considering each separate area, or plane surface, to an inconsiderable amount. Six miles square is not far from the average area of townships in the northern, middle, western and most of the southern States. The bulge of curvature, or the versed sine of half the arc of 6 miles, would be about 6 feet. This would make the proportional difference between the straight and the curved distance, or between the length of the chord and of the arc, much less than the percentage of probable error inseparable from measurements of the utmost attainable precision in actual practice. Township boundaries, therefore, would seem to afford the most convenient divisions between separate co-ordinate systems. If, however, as is the case in a few of the southern States, no smaller civil subdivisions than counties exist, these are not usually so large that the use of a single co-ordinate system over its area would involve any important error.

DIRECTION OF AXES.

The most appropriate and convenient directions for the axes would doubtless be found in meridians and perpendiculars to them, since azimuths reckoned from the meridional axis would then conform very nearly to the true astronomical azimuth. Owing to the convergence of meridians, there would be a small variation from the true azimuth increasing with the distance from the axis, but no practical error need arise from this cause. The true azimuth, if needed, is easily computed by the formula,

$$\tan. \tfrac{1}{2} C = \sin. L \tan. \tfrac{1}{2} P,$$

in which L is the middle latitude between the origin and the point where the convergence is to be computed, P the difference of longitude between the same points, and C the convergence sought. In passing from one district to another, however, a certain degree of complication arises and it becomes necessary to take the convergence into account. We may, without practical error, consider any two adjacent districts as lying in a plane produced by developing a conical surface tangent to the earth on the middle parallel of latitude between the origin of the two districts. On this plane, the convergence of the meridional axes of small districts will conform to the above formula, and the small angle of convergence measures the change of direction between the co-ordinate systems of the two districts.

PASSING FROM ONE DISTRICT TO ANOTHER.

In the passage from one district to another, four different cases of transformation of co-ordinates arise, namely:

1st, When the origin of the new system is east and north of the origin of the old system.

It will of course, be necessary while assigning positive values to latitudes and departure in one direction to give negative values in the opposite direction; thus if north and east are to be reckoned as positive, south and west must be reckoned as negative.

(*To be continued.*)

* More exactly 0.000052 inches, for we have radius = 57.3°, nearly, in terms of arc; or, making radius = unity, 1° = 1-5738′ 1″ = 1-206,280 and 1-288,000 = 0.71″ nearly. Conversely, in terms of distance, if radius = 15 inches, 151-288,000 = 0.000052 inches.

PREVENTION OF IRON RUST.

A very important paper has lately been read before the Society of Arts by Mr. Barff, Professor of Chemistry to the Royal Academy, upon a method of preserving iron from rust by coating it with its own magnetic oxide. The facts which Prof. Barff has brought forward, and the specimens which he has exhibited, are such as to justify the belief that his discovery will prove to be one of enormous value, and that it will, indeed, render all kinds of iron-work, however much exposed to weather, or to corrosive vapors or liquids, practically indestructible and everlasting.

When an iron surface is exposed to the action of water, or of moist air, it speedily becomes covered by a film of protoxide or ferrous oxide, which consists of 56 parts by weight of the metal to 16 parts of oxygen. The ferrous oxide continues to attract oxygen from the atmosphere, and is gradually converted into another compound, the sesquioxide, or ferric oxide, which is composed of twice 56 parts by weight of iron, and three times 16 parts by weight of oxygen. The ferric oxide, in its turn, gives up some of its oxygen to the as yet unoxidized iron beneath it, and the ferrous oxide thus formed is gradually converted into ferric oxide by the access of air through the spongy layer of superficial rust which covers it. In this way the first formed film of rust exposes to the atmosphere the surface which lies below it; and hence the rust becomes a carrier of oxygen to the deeper parts of the iron, until the latter is completely corroded and worn through. Many attempts

have been made to protect iron surfaces by the application of some kind of paint or varnish; and these attempts have, of course, been to some partial extent successful. Such coatings, however, have no real adhesion to the metal on which they are placed, and are liable to scale off or to perish in a variety of ways, Even when the coating is generally sound, the smallest flaw in its continuity will give entrance to the enemy; for the rust from the exposed spot will spread laterally under the coating, and may be all the more dangerous and destructive from being partially concealed from view.

It is manifest that the evils incidental to rusting are entirely due to the unstable character of the two oxides already mentioned, which are formed spontaneously under ordinary climatic conditions. There is, however, a third oxide which possesses characteristics of a totally different kind, and which is uninfluenced, not only by moist air, but even by acids and other corrosive substances. This is the magnetic or black oxide, which consists of three times 56 parts by weight of iron, and four times 16 parts by weight of oxygen. Prof. Barff has discovered that if any iron article is exposed, at a high temperature, to the action of superheated steam, it will become covered by a film of this black oxide, of a thickness which is determined by the degree of temperature and by the length of exposure. The oxide is harder than the original iron, and adheres to it even more firmly than the particles of iron adhere to each other, so that there is a gain not only in chymical, but also in mechanical resistance. If the operating chamber is heated only to 500 degrees Fahrenheit, and the exposure is continued for only five hours, a surface is obtained which will resist emery-paper for a considerable time, and which will not rust within doors, or after any moderate degree of exposure to moisture. If the oxidizing process is conducted at 1,200 degrees Fahrenheit, and continued for six or seven hours, the surface will resist a rasp, and will bear any amount of exposure to weather. The oxidation does not affect the appearance of the surface in any other way than by turning it black. A rough forging retains its roughness, and a turned or polished surface retains its smoothness. If there should be any flaw in the coating, or if the black oxide is designedly removed from part of the surface, the common oxidation will occur where the iron is thus left unprotected. But such oxidation is strictly limited to the unprotected portion, and has not the smallest tendency either to spread laterally under the black oxide or to detach this from the subjacent parts.

Prof. Barff has as yet been limited in his operations by the want of a heating chamber large enough to treat iron articles of considerable size, but he has prepared a great number of specimens of small articles, and these have been subjected to tests of every kind. Such things as bolts, rivets, screws, door-handles, gun-barrels, water-pipes, railing-heads, cast-iron saucepans, and other articles too numerous to mention, have been left for six weeks of the recent wet weather upon a lawn at Bayswater, and at the expiration of that time were taken up absolutely unchanged, and without a speck of rust except upon parts which had been left, either by design or accident, without protection. One of the specimens shown by the Society of Arts was a long bolt, from half the length of which Prof. Barff had cut away the coating of black oxide before leaving the bolt upon the lawn. The scraped portion was covered with a considerable thickness of sesquioxide, but the coated part had remained unchanged, and it was impossible to raise the film of black oxide at the line of demarcation. The film was an integral part of the iron itself, and the one could not be detached from the other. Another specimen was the head of a pipe for collecting roof-water, which had been broken by a sledge-hammer after it was coated, and then thrown into a sink in Prof. Barff's laboratory, where not only water, but many corrosive liquids, were constantly passing over it. Rust had formed at the fractured edges, but the protected surfaces were wholly untouched.

Among the most valuable and important of the probable applications of the invention will be the protection of steam boilers and of the plates of iron ships; and Prof. Barff hopes that by certain arrangements it will be possible to operate upon very large manufactured articles without its being necessary to provide a heating chamber large enough to contain them. The applications seem almost without number. The process will be conducted at very small cost, and it will probably be employed, at no distant time, for iron goods of every description. Not only so, but it will extend the applications of iron itself to several purposes for which its liability to rust has hitherto rendered it unsuitable. Copper vessels will no longer possess any advantages for cooking, and iron saucepans will no longer need to be tinned. Leaden pipes for the conveyance of water will in all probability be entirely superseded; and there can be no doubt that new uses for incorrodible iron will every day suggest themselves. Messrs. Penn, of Greenwich, are about to undertake a series of trials for the purpose of testing the strength of the prepared articles, so that they may become able to speak with authority upon the fitness of the oxidized iron for bridge girders and architectural purposes; and Prof. Barff is himself fitting up a heating chamber of a larger size than that in which his early experiments were conducted, and will before long be in a position to furnish evidence of the commercial practicability of his process.—*London Times.*

HEALTH BOARD OF NEW YORK.

In a recent statement made by the officials of the Health Department an attempt was made to prove that in New York the death rate was much lower than in nearly all the large cities either in this country or in Europe. In order to prove this much to be desired sanitary result the mortality for the past quarter was taken as a basis for calculating the present yearly death rate. There having been 6,002 deaths within this period, and the population being estimated at 1,077,228, a rate of mortality of 22.28 per 1,000 was obtained for the entire year. No one is better aware than the gentleman who prepared this statement for the Health Board that it is incorrect and not a true exhibit of the present rate of mortality for this city for the following reasons:—In the first place, the three months just passed have proved to be unusually healthy, thanks to the extremely fine weather, consequently the past quarter is not a correct or just basis to make such a calculation; secondly, it is a well known fact that can be easily proved from the reports of the Board of Health that the excessive death rate from zymotic diseases is always from about July to October. This is in keeping with the experience of every physician in the city. The Eleventh ward has a death rate of 35 to 40 per 1,000 (yearly rate) during the heated term. While in the winter months the rate is seldom or never below 26 or 28 per 1,000. At page 236 of the last Health Report the following statement is made:—

"More than half the inhabitants are living at such a disadvantage as respects their domicile and their social state that they are comparatively incapable of resistance to the local causes of disease, and during the hottest and coldest periods of the year the more unhealthful quarters become excessively perilous to great numbers of their residents. The special insalubrity of these limited districts of uncleanliness and overcrowding is shown by the fact that children under five years of age perish at the rate of 250 to 300 per 1,000 (yearly rate) during the ten or twelve hot weeks."

From the foregoing extract from the official reports it will be at once seen how absurd it is to draw any estimate as to the actual death rate from the returns of three months, particularly when the period selected gives a much smaller rate of mortality than either the third or fourth quarters of the year.

It can hardly be disguised that this last statement of the Board of Health has been made in order to induce the public to believe that the mortality in this city is much less than it really is, and that, thanks to the vigilance and ceaseless activity of the Health officials, New York is one of the healthiest cities in the world.

It has been rapeatedly urged by the New York *Herald* that much of the disease and sickness that affects this city is to a very great extent preventable provided the proper means and precautions are adopted.

Until reorganization and change be made in the management of the Department of Health but little improvement can be expected in the sanitary condition of the city, for under the present system no attempt will ever be made to remove the great sources of danger to the public health which exist within the city.

The Health Department should be entirely freed from all political changes and the influence of politicians and run in the interest of the people, and not made a species of medico-political asylum, as it has been in the past. The department should be modelled on the plan of the present Department of Public Works, in so far that it should be placed under one head, to be appointed by the Mayor, and who should hold office as long as his management and the sanitary condition of the city justified. The city should be divided into sanitary or health districts, about fifteen in number, each being placed under the care of a sanitary inspector, who should be appointed by and be responsible to the Health Officer for the condition of his district. The Street Cleaning Department should divide the city into districts to correspond to the health divisions, and the work of street cleaning divided up in this way could be done much cheaper and it need hardly be said in a much better and more satisfactory manner. The sanitary inspector of each district should also be charged with the work of supervising this work, and his weekly certificate that the work has been properly done should be necessary for the contractor to obtain his pay. The clerical force of the department could be materially reduced; also the "contingent" and "stationary" accounts might be made a little less in the future.

One of the greatest evils in the present system is that there is too much division of responsibility, and the health affairs of the city are managed by the chiefs of the different bureaus and not by the Commissioners of Health. One of the special benefits to be derived by a change such as is suggested above would be a concentration of authority and the direct responsibility of the chief officer of health, who should be obliged to devote his entire time and energies to the protection of the public health, and not, as is now the case, every member and attache of the Board having also his own private affairs to look after. By such a system as this, economy and efficiency will be secured, the city will be rendered clean and healthy and over $150,000 will be saved in one department, and can be devoted, if necessary, to the abatement of public nuisances. The badly constructed tenements can be improved with this fund, and the expense, as the law directs, made a lien on the property itself, thus securing the city from any loss and insuring a positive safeguard to the public health.

IMPROVED BOILER FEEDER.

Of the numerous primary points involved in the economical production of steam power, not the least worthy of consideration is that of *feed-water*. In all non-condensing steam engines, the exhaust at every stroke of the piston carries into the atmosphere a large portion of the heat from the boiler, which is thus a source of waste of no mean magnitude. It is obvious, therefore, that any device by which this heat is wholly, or in part, utilized, effects a direct saving of fuel in proportion to the number of heat units returned to the boiler after the steam has performed its duty. Of course a certain percentage of loss from radiation is unavoidable; but, by the proper use of non-condensing jackets upon all exposed surfaces with which the steam comes in contact, the loss from this cause may be rendered so small as to be comparatively inconsiderable. The waste of heat by the exhaust may be briefly illustrated as follows: In boilers for non-condensing engines the ordinary working pressure is 60 lbs. per sq. inch, above atmospheric pressure—the temperature due to which is about 311° Fah. of *sensible heat*. Now, it is clear, that if we exhaust directly from the cylinder into the atmosphere, without making any further use of the steam than the propulsion of the piston, the loss of heat will be 311°, minus the natural temperature of the water used to supply its place—the equivalent heat units of course depending on the volume of steam at above pressure. For instance: If the temperature of the feed-water be 70°, the loss will be 241°, or that number of units of heat contained in the difference between a cubit foot of water at 70° and 383 cubic feet of steam at 311°—In round numbers about 2970 units per cubic foot. If by any device we are enabled to return to the boiler 212° of this heat, the loss will be but 99°, or about 135 units. Thus the saving is 2835 heat units, or 80 per cent. of the previous waste.

These figures being necessarily purely theoretical, must only be taken as an approximation of the practical result, but the comparison, either on practical or theoretical basis, will be found about the same. An apparatus for this purpose (although by no means the pioneer in the field), has recently received the favorable notice

of parties using steam boilers. It combines not only the pump and heater, but also a partial condenser, by means of which all back pressure from the exhaust is removed. The heater actually *does* deliver the feed water at 212°, although doubtless there are many who would be skeptical as to the possibility of attaining such temperature from exhaust steam.—*American Manufacturer.*

TRIP OF CIVIL ENGINEERS TO BONNET CARRE CREVASSE.

MONDAY, *April 30, 1877.*

Upon the invitation of Major Boyd, of the Coast Survey, a number of the members of the Society of Civil Engineers had a delightful excursion up the river to the Bonnet Carre Crevasse. They embarked at Carrollton, accompanied by Professor Forshey, on board the Coast Survey steamer "Baton Rouge," and, through the kindness of the proper authorities, the U. S. Revenue cutter, "John A. Dix," there joined the party, and took the survey boat in tow, thus enabling all to make a quicker trip. The day was lovely, and the plantations with their splendid foliage presented a charming sight, especially to northern eyes fresh from scenes where the snow had so recently whitened the prospect.

Major Boyd had kindly provided an elegant repast, which was enjoyed by all on board shortly before arriving at the Crevasse. Commander McGlensey, of the monitor "Canonicus," and other officers of that vessel, had joined the company at Carrollton, adding, by their geniality, to the general pleasure. The officers of both vessels appeared determined that no attention should be spared that would add to the comfort of the party.

After passing slowly along directly in front of the Crevasse, the party landed a short distance above on the levee, and walked down to the Crevasse, where they observed the river pouring thro' the gap with a velocity of three to four miles an hour, on a length of about a fourth of a mile, having much of the way a depth of over forty feet. This depth, however, does not continue; it soon shoals up to a depth of about eight feet, at the present stage of the river (which is about eleven feet above low water, and within two or three feet of ordinary high water).

Some time was spent in walking along the levee and in examining and discussing the Crevasse. The opinion that it should be closed at the earliest practicable moment, and before the coming of another high river stage, seemed to be universal among the engineers who saw the place and knew its history. The destruction of property caused by this Crevasse has been enormous, and it will increase, unless immediate steps be taken to stop the floods which pass out through this Crevasse. Besides the vast damage to the plantations along the river for long distances above and below, the discharge of such immense volumes of fresh water, loaded with sedimentary matter into Lake Pontchartrain, is injuring the value of that beautiful sheet of water, ruining the property owners around the Lake, and destroying many favorite summer resorts of the people of New Orleans and other places. The loss of so large a body of water, amounting to one-tenth of the entire flow of the Mississippi at that place, must have the effect of shoaling the river just above the head of the passes; so that the people of the whole Mississippi valley have a direct interest in closing this outlet at once.

About four o'clock in the afternoon the company bade good bye, with hearty cheers, to Major Boyd, and returned to the city; everyone expressing the gratification they felt at having the opportunity of seeing this great Crevasse under such favorable auspices.

On the way up the river Major Boyd took occasion to explain very clearly, with the aid of his maps, etc., their methods of surveying by triangulation, and their use of the plane-table in taking the topography.

The whole excursion was particularly enjoyable, and eminently satisfactory to the members of the Society and others of the excursionists.

The revenue cutter landed the party at the foot of Jackson street about six o'clock, where the whole company joined in three hearty cheers for the Captain and officers. Thus ended one of the happiest excursions of the season; and it is hoped that it will bring forth good fruits.

W. M. R.

CORRESPONDENCE.

SHAWANO, WIS., *May 1, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—Allow me to cangratulate you upon your complete success in making the NEWS a *standard first-class* Journal, which must continue to be indispensible to the profession.

A terrible "northeaster" snow storm has just been raging here (on the 28th and 29th ult.) amidst our farming and *log driving* operations. Snow one foot deep with temperature at sunrise 10° F. During the latter part of March five inches of snow fell which enabled the "loggers" to *bank* about one-third of the amount intended.

The log *owners* are now hopeful as the log market will not be glutted as heretofore and good logs will be sure to command better prices.

It has been estimated that Wolf River and its tributaries will raft at the boom fifty millions feet of white pine logs.

Flour is eleven dollars per *barrel*, with a fair prospect for good crop of winter wheat.

President Hayes' conciliatory policy so successful at the *South*, which, together with his honest and economical administration of affairs at Washington has *practically restored confidence*, and business operations will soon resume unusual activity.

"La patience est amere, mais son fruit est doux.

Respectfully yours, J. M.

PROVIDENCE, R. I., *April 25, 1877.*

EDITOR ENGINEERING NEWS:

SIR.—I find two misprints in my last letter, ten 22" sewers instead of two; also 40 acres instead of 400. Please correct the same. I would like some of the readers of your paper who have taken observations upon the flow of water, to give the results as compared with formulæ, or the conditions of result, so that we might be able to compare for ourselves. I found as comparing Neville 140. $\sqrt{RS} - 11\sqrt[3]{RS}$ with a sewer 38"×57" grade, or $\frac{H}{2}$, or $S = \frac{9}{1000}$ and the sewer was 18" deep, the H M R $= \frac{4}{5}$ of .8, or 9.6 inches. Now, the surface velocity was found by experiment, 10 feet per second, taking 4-5ths of this for mean, gives eight feet per second. Neville's formulæ as given, gives 11.70 per second, which is not applicable in this case; but if we take his book upon Hydraulics, page 439, second edition, and take 9 inches as the H M R, we get 8.13 as the velocity; and if we take Molesworth $V = 55\sqrt{x \times 2f}$ per minute, where x = H M R and f = the fall in feet per mile, we get 8 feet per second: and if we take $100\sqrt{RS}$ we get 8.15 feet per second, so that they all three come practically the same. But the last experiment on the 66 inch and this one was make upon sewers, you might say, perfectly smooth, and the results obtained in Providence (I am speaking from experience) would be greater than a great many places I am acquainted with—the main sewers are, as a rule, equal to the best I have seen in England.

I would also wish that some of the engineers who have had considerable experience with the Tidal drains, would contribute to the paper, for I think there is yet a great deal to learn upon this matter. I should say for myself that drains or sewers which are tide locked ought to be calculated from their worst condition, that is, as far as the tide flows in them, for when the tide is up there is no grade, and the only advantage of grade that I can see is, to clean them when the tide is out; what I mean to say is this.—that if a sewer has a grade say 1 in 2000 or 1 in 500, when the tide is out, that the distance the tide flows up the sewer, for that distance it destroys the grade on that section, so that the conditions are, that the sewer in that part is level and should be considered as such when making calculations for the size, etc., or if the sewer is to be trapped or have a tide-gate, then you must consider it has a reservoir for that district below tide level, which I think is a disadvantage in a great many cases.

In answer to J. in April 21st, No. 1.—Some engineers believe in making a step or square fall in the M H where changes in sizes should always come, but I should say, keep the water lines equal; if a curve and a M H at the ends of the curve, make the grade more around the curve for the difference in size. No. 2.—Keep the water lines even but let the lateral drains enter the main sewers so that their water lines are above the general sewage flow for the main sewers, and change at manholes as before stated. No. 3.—Velocity enough to keep clean always, which must be determined according to the specific gravity of sediment.* No. 4.—Hurst says, calculate two-thirds full, and has tables for the sizes, but I should say from the conditions given, having ventilators and free outlets, and the almost impossibility of filling sewers unless too small, that the space is of little account.

W. W.

A NOTABLE RAILROAD RUN.

The unusual run of the fast special train over the L. and N. road Sunday is worthy of something more than a passing notice, as it shows that the condition of the road is not only excellent, but its working organization is practically perfect. The train left here at 8 A. M., with the American Society of Civil Engineers, and made its first stop at Colesburgh, where it arrived *exactly* on time. It then run along to Bacon creek, where it arrived *exactly* on time.

To Bowling Green it then went, where it arrived also exactly on time. Here engines were changed, and on it sped to Nashville, where it arrived on schedule time, and so on with wonderful exactness, to Montgomery, where it arrived at 12:25 A. M., 16 hours and 25 minutes from Louisville, a distance of 490 3-10 miles. Forty-five minutes were consumed for meals along the line of the road.

When it is remembered that the L. and N. is a single track road, with a heavy freight traffic, which was not delayed in the least, and that the average speed of the train in question necessarily had to be over forty miles an hour between stations, it cannot fail to convince every one that the organization of the road is in the hands of the most skillful of men.

The American Society of Civil Engineers is composed of the more talented of their profession gathered from all parts of the country, and these gentlemen of science were very hearty in their commendations of the condition of the track and road-bed that carried them along so smoothly and regularly at so high a rate of speed.

This record of the capacity of the road proves very conclusively that the L. and N. is entitled to the position it holds, that of being a member of the best and most popular route from New York and the cities of the North and West to all parts of the South and Southwest. —*Louisville Courier Journal.*

THE TOPOGRAPHY AND DRAINAGE OF NEW ORLEANS.

BY THOMAS S. HARDEE, CITY SURVEYOR.

The topographical situation of the city of New Orleans is such, on account of its flatness and the proximity to tide level, that the establishment of an efficient and adequate system of drainage has been a problem exceedingly difficult to solve. But an extensive work is now progressing, as shown upon the accompanying diagram, and far advanced towards completion, under a contract with the Mississippi and Mexican Gulf Ship Canal Company, which when completed will revolutionize the present circumscribed system, and it is believed will protect the city effectually from both river and lake overflows, and at the same time simplify and perfect the system of interior drainage for the rapid discharge of all water from the rainfalls and otherwise.

When this work is perfected, an opportunity will then be offered, through more enlarged drainage, to establish a system of underground sewerage, so that the present nuisances of open drains and canals can be abated. This will be effected principally by means of the proposed powerful draining engines, which will be located at the outer limits of the drainage area, and which will be able to reduce the water very considerably below the present inside low water stage, thus creating an additional fall of several feet from the front to the rear more than it now is, increasing the capacity of the outer canal reservoirs, and by this means enabling the bottom or foundations of the present open canals or drains to be lowered, so as to receive the sewerage of the city through permanently constructed covered sewers.

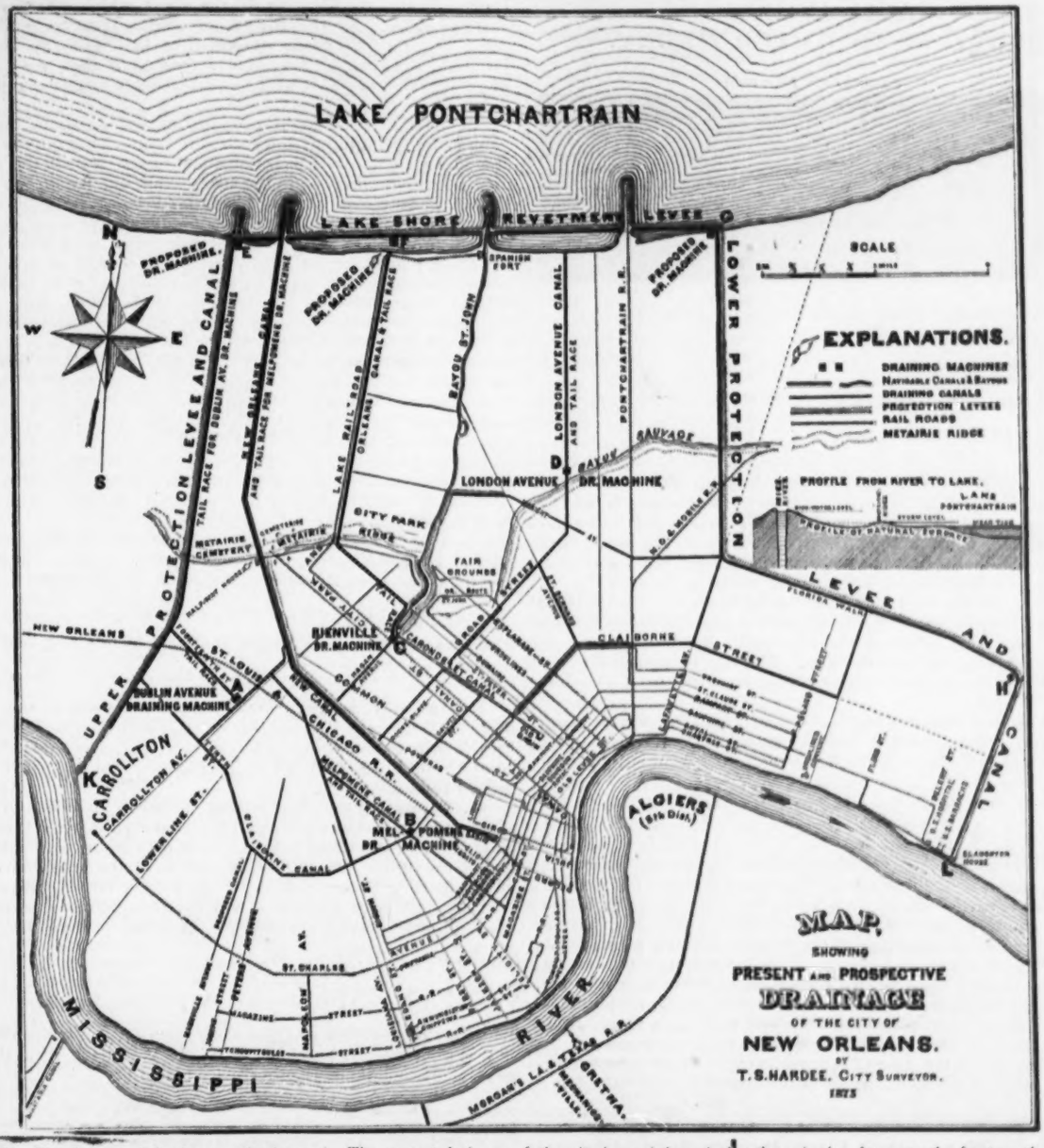
The benefits to the health of the city by the accomplishment of this object alone will be incalculable, and with the combined advantages of protection from overflow and the rapid discharge of all rainfall, there is no reason why New Orleans should not be one of the healthiest and most desirable cities on this continent for a permanent residence. This is certainly a goal to reach, which, if attained by the outlay of millions, will be a trifle as compared to the advantages gained and the benefits bestowed.

The bane of New Orleans as a progressive city has been, that for the want of proper drainage and the evils resulting therefrom, the place has offered but few attractions for the building up and embellishment of homes; and the consequence has been that the bulk of the fortunes which have been made in mercantile pursuits, and which ought to have remained here for investment, have been diverted and taken away to assist in improving other localities more favored by nature in this respect, or which have been redeemed by the successful appliances of art.

The city of New Orleans, with the exception of one district out of seven, known as Algiers, is situated on the east bank of the Mississippi river and this main portion, embraced within the prospective drainage limits, contains about 26,000 acres of superficial area. The city is bounded on the north, or on the side opposite to the Mississippi river, by Lake Ponchartrain, which is an average distance of about five miles from the river. The distance by the course of the river on the front of the city is about 13 miles, and along the shore of Lake Ponchartrain in the rear, the distance is only about five miles. The reason for this apparent inequality is, that the shore line of the lake is comparatively straight, while the course of the river is tortuous.

About half way between the lake and the river there is a natural high ground, called Metairie Ridge, which runs entirely across the city, and which is elevated about four and a half feet above mean tide water. There is a basin or low ground between this ridge and the river, and a flat swampy plateau between the ridge and the lake.

The natural banks of the river on the city front have



been raised uniformly several feet by an embankment commonly designated as the Levee for Protection against river overflow, and the crown of this levee is the most elevated surface of ground within the corporate limits. There is a dish or fall of about five feet in this levee, from the crown to the streets a few blocks distant, so that in the high water season the surface of the river is almost on a level with the heads of the busy pedestrians who ply their vocations in the vicinity.

The water in the river rises and falls about fifteen feet between the extremes of high and low water, and the flood season is confined generally to the months of March, April, May and June.

With the above description, and with the aid of the profile shown upon the diagram, a clear idea can be entertained of the average cross section of the city embraced between the high water of the river and the highest storm level of the lake, showing also the ground intervening between the two which it is necessary to drain and protect.

The fluctuations in the surface of Lake Ponchartrain vary about four feet from the very lowest to the very highest water produced by storms, but the ordinary tidal oscillation is only about eight inches. Owing to these storms, which are periodical, the city has to be guarded against inundations from the lake, in addition to being protected from river crevasses, and hence a combination of difficulties surrounds the question of drainage and protection.

The peculiarity of the water in the river at certain seasons, being so much higher than the adjacent land, renders it necessary that the drainage should be into Lake Pontchartrain, not only as being the natural outlet, but also as offering fewer difficulties than a forced drainage into the river, on account of the difference in elevation, to be overcome in lifting the water.

The present drainage of the city is carried on by means of four draining machines located at A, B, C, and D respectively, as shown upon the diagram. A line connecting the several draining machines will afford a very good idea of the length and extent of the inhabited or built up portion of the city, embracing as it does the space between the river and such a line. These machines each drain a particular section or district of the city, and are located at about the lowest elevation, so that the water which falls upon the slope of each section is conducted by gutters and ditches to the draining point, whence it is lifted by machinery into the level of the lake through the agency of a tail race connecting the draining machine with Lake Pontchartrain. These tail races, which are several miles in length, are formed by a canal about 50 feet wide, the sides of which are strongly leveed for protection against lake overflow, and through them the water level of Lake Pontchartrain is backed up immediately in contact with the draining machines. The tail race forms therefore, a discharging funnel, and the water which falls in each section and collects at the draining machine must pass through this funnel before being distributed into the discharge level of Lake Ponchartrain.

The draining is effected by means of large wheels, with paddles attached similar to an ordinary steamboat wheel, and the revolution of this wheel by steam power, forces a folding iron gate to open, and through this opening the accumulated volume of water is pushed into the tail race, and thus the inside area is relieved.

In connection with the present draining machines there is a continuous back levee as it is called, which keeps even the ordinary tide water of the lake from encroaching upon the low lands in the rear embraced in each section, and this chain of back levees connect with an upper and lower side levee, as well also as the main river levee on the front, so that the entire present limited area drained is walled in by a continuous and connecting embankment of earth. This condition must of necessity exist, owing to the peculiar topographical situation of the city, and the same principle has been adopted for prospective drainage under the enlarged system now being prosecuted by the Mississippi and Mexican Gulf Ship Canal Company.

The *new* and *enlarged* system as contradistinguished from the *present* and *circumscribed* one, is clearly defined upon the diagram.

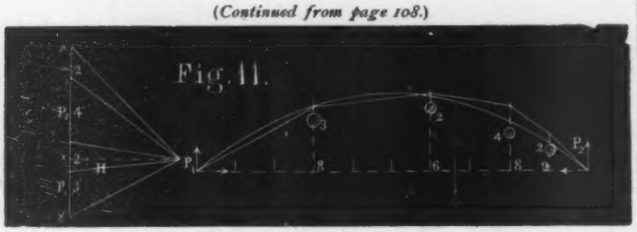
When this new work is completed, the enclosure or embankment wall will then be composed of an upper protection levee from K to E, a lake shore revetment levee from E to G, and a lower protection levee from G via H to L. These three links will form a chain with the already established Mississippi River levee, and will enclose, as before remarked, about 26,000 acres of superficial area. The drainage machines will then be transferred from A, B, C, and D, to the proposed points at E, F, G, and H, and with improved and more powerful machinery will be enabled to relieve effectually every foot of land between the river and the lake.

To be Continued.

T. H. Hamilton, of Toledo, O., who was awarded the contract, on the 20th ult., for the construction of the new dock of the Columbus & Toledo R. R., at Toledo, O., is at present actively engaged upon the preliminary portions of the work with a large force of laborers. The length of the dock is to be 1080 feet x 140 feet, and it is to be completed Aug. 15th next, the expense of the work being about $50,000.

ARCHES;
CONSIDERED GRAPHICALLY.

(*Continued from page 108.*)



$$P_1 = \frac{2\times1+4\times2+2\times4+3\times7}{10} = 3.9 \text{ tons.}$$

$$\therefore P_2 = 7.1 \text{ tons.}$$

From the table for H,

$$H = (0.3176\times3 + 0.372\times2 + 0.232\times4 + 0.1226\times2)\frac{50}{20} = 2.87\times\frac{5}{2} = 7.175 \text{ tons.}$$

These quantities are plotted in the stress diagram, as seen in the figure, and the funicular polygon is then drawn. The reader who reproduces this polygon, or draws another, can be assured of the accuracy of the construction by the closing of the curve of equilibrium on the point of support. The weight of the arch itself may be accounted for by concentrating the proper amount at each point of division, the amounts increasing towards the springing in proportion to the square of the secant of inclination to the horizon; for we recall that the parabolic rib is to increase in breadth from crown to springing, and the amount in length projected into a horizontal foot increases in the same way. The weight of each division of the arch can be obtained with sufficient accuracy from a moderately large figure.

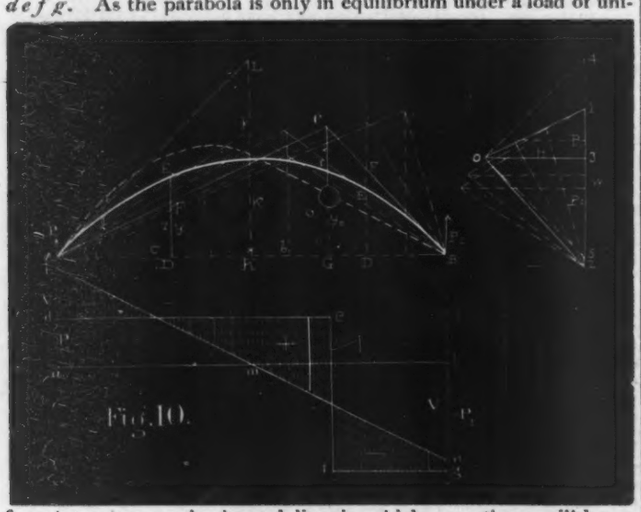
It will be seen that the two curves of Fig. 11 approach quite nearly at 3. We can find the distance between them vertically, if we wish, from the table of M. The bending moment will be, taking the column 6,

$$50\,(+.153\times3 - .073\times2 - .075\times4 - .043\times2) = .3650 \text{ ft. tons.}$$

$$\frac{M}{H} = \frac{.365}{7.2} = .05 \text{ ft.} = y - z.$$

55. It was shown in § 19, where what is meant by *shear* was explained, that it is useful to know the amount and the distribution of the shear at each section; since whatever is not taken up in the flanges or chords of the rib, by being combined with H to give a resultant thrust in the direction of the tangent at each point, must be resisted by the web or bracing. This investigation of shear is intended to apply to ribs of an I section, or to those framed with open-work or skeleton webs, and not to those of solid section, rectangular, circular, or otherwise, nor to stone arches; in these latter classes the shearing forces need seldom be taken into account.

Adhering still to the case of a single weight W, at a distance b from the middle of the span, the vertical component of the reaction, P_2, at the end nearest to the weight will be $\frac{c+b}{2c}$ W, and at the other end $\frac{c-b}{2c}$ W. As seen in Fig. 10, the diagram for total shear wil be, if we take the shear on the *left* of any section, $a\,d = P_1$, on the left of the weight, and $l\,g = -P_2$ on the right of the weight, giving the two rectangles included between $a\,l$ and the broken line $d\,e\,f\,g$. As the parabola is only in equilibrium under a load of uniform intensity on a horizontal line, in which case there will be no bracing required, and therefore no shear for any bracing to resist, it is manifest that the diagram for the shear which is carried, at each vertical section, by the flanges or chords must be similar to the shear diagram for a beam supported at both ends and uniformly loaded, that is, to such a figure as $a\,i\,m\,n\,l$. If then we can determine the value of $a\,i$, or of the equal ordinate $l\,n$, we can draw this diagram.



56. It is a well-known property of the parabola that a tangent at the springing of the arch will intersect the middle ordinate at a distance k above the crown, equal to the rise of the arch. If then we draw a line 0–4 in the stress diagram, parallel to the tangent A L, drawn as just described, the distance 4–3, intercepted on the vertical line, will be the amount of vertical force necessarily combined with H to give a thrust coinciding with the rib at the springing point. Lay off, therefore, 4–3 at $a\,i$ and an equal amount at $l\,n$; then draw the straight line $i\,n$, cutting $a\,l$ at its middle point m; the ordinates to this line from $a\,l$, at all points, will represent the amount of vertical force combined with the horizontal thrust in the flanges. The remainder will be left for the web. The shaded areas represent the remaining ordinates, and, where the amount subtracted by the flanges is greater than the original shear, the remainder will be of the opposite sign. The signs are placed in the areas in the figure, and it will be apparent that the ordinates are practically reckoned from the inclined line $i\,n$, all above that line *on the left of a plane of section*, while those below $i\,n$ will be negative. It is understood that the two flanges or chords have parallel tangents at every right or normal section; otherwise special treatment is required.

57. The calculation of the shear on the bracing is attended with no difficulty. If V = vertical component of the thrust in the rib at any point, we have at the springing, from the statement just made,

$$V_1 : H = 2k : c, \text{ or } V_1 = \frac{2k}{c} H.$$

The shear F on the web, at the abutment on the left, will then be

$$F = P_1 - V_1, = \frac{c\pm b}{2c} W - \frac{2k}{c} H. \qquad (14.)$$

For successive points, P_1 will remain the value of the original shear until we pass the weight, when it will become $P_1 - W$ or $-P_2$. V will diminish at a constant rate, and, if we deduct at each point the ordinate from a l to the inclined line, we shall get the desired results.

58. Let us find the shear *midway* between the points of division of an arch divided into ten equal horizontal parts, for a load on the same point as was taken before, *i. e.*, at 0.4 c from the middle of the span to the right. The load being 3-10ths of the span from one end, the supporting forces will be 0.7 W and 0.3 W respectively. As the shears are to be taken half-way between points of division, the *spaces* are numbered from the left. W comes between the 7th and 8th spaces. $H = .3176\frac{c}{k}$ W.

$$V_1 = \frac{2k}{c} H = 2\times.3176\,W = .6352\,W,$$

the values of the *span and rise disappearing*, and hence this value of V is good for any parabolic arch. If V = .6352 W at the abutment, at the middle of the first space it will be

$$V = (.6352 - \frac{.6352}{10})W = .572\,W,$$

the value placed in the third line at the first space; for every succeeding space V will diminish by $\frac{.635}{5}$ W or .127 W.

VALUES OF F. W.

SPACE 1		2	3	4	5	6	7	8	9	10	
P_1	.3	.3	.3	.3	.3	.3	.3	−.7	−.7	−.7	$-P_2$
V	.572	.445	.318	.191	−.061	−.064	−.191	−.318	−.445	−.572	
P−V.	−.272	−.145	−.018	+.109	+.236	+.364	+.491	+.382	−.255	−.128	W

Thus we get the third line of the table, and P−V gives the desired values of F in the last line. Three decimal places here will be as exact as four in the values of M. If anyone has trouble with signs, an inspection of the shear diagram of Fig. 10 will show where and why they change; the computed quantities are represented by the full lines of the figure.

We repeat again that, because P_1 was taken as positive to commence with, the above table gives the value of the shear on the left side of a vertical section at the middle of each space. In Fig. 12, the sketch marked R is an instance of positive shear on the left of the imaginary section and its accompanying negative and equal shear on the right of the same section. It is therefore evident, from the way in which the two parts of the arch will tend to slide by one another, that, where the shear on the left is upward, or positive, a tie will be required sloping from the upper chord to the right (or a strut in the opposite direction), while negative shear, as represented in the sketch marked S, calls for tie in the reverse direction.

(*To be continued.*)

ARE RESIDENT ENGINEERS NECESSARY?

When those classes of construction known as engineering works are initiated and in progress, the services of members of our profession are usually called for, to see that all parts are executed with due regard to stability, strength and permanent resistance to the elements. In cases where the finished structures are exposed to little deterioration from the lapse of time, the subsequent employment of an engineer is not customary, but where more or less renewal of parts or additional protection is likely to be required it is generally the practice to employ a resident engineer, with such a staff as the extent of the work may render necessary. We find such an officer in the employment of most of those railroads which are of considerable length, and which have difficult and expensive works on their lines. From our own point of view we might say that we find a chief engineer on every well-conducted railroad, for we doubt if a road is long well-conducted without.

We are moved to this line of remarks by noticing that two of the companies which run from Chicago have lately made a move for retrenchment in expenses, by abolishing their engineering departments, and we know of a New England road where the impression is prevalent that, if the chief engineer was not practically discharged, the directors made up their minds that his services might well be dispensed with and he consequently resigned.

In the Western cases above referred to, it is stated that the duties heretofore devolving upon the engineers have been turned over to the division superintendents, subject to the oversight, where required, of a consulting engineer. Our esteemed contemporary, the *Railway Age*, remarks,—"The perfect condition of the road-bed and superstructures, and their permanent character, seem to render this, for the time being, at least, a safe step—as it is certainly an economical one—though the example could hardly be followed with propriety in this country at present, unless, indeed, the division superintendents are themselves competent engineers. It is believed by some that they always should be, and yet a great majority of our most successful superintendents and managers have worked up from the ranks of the operating department, and their acquirements are almost wholly practical rather than theoretical."

Mr. John B. Jervis, C. E., a gentleman past eighty years old, whose engineering experience dates back to 1817, and who has had charge of many and various important works, in a memoir of American Engineering, published in the February number of the current volume of the Transactions of the *American Society of Civil Engineers*, devotes a few paragraphs to the subject of Engineers as Railway Superintendents. His experience in such a position lends weight to his words, and his years will acquit him of egotism. Not to quote more than two or three sentences, he says—"My object is to show that an engineering education fits a man best for the superintendence, no less than for the construction of a railway. I regard it an error that the profession has not given more attention to superintendence of operations. It demands the same thoughtful analyzing mind, to operate, that constructs." "The engineer's education fits him to analyze facts, and, more successfully than a layman, to produce the best results of administration."

If managers and superintendents were engineers, as they are in some cases, and as Mr. Jervis urges that they should be, we might, with an eye to economy, and a due regard to public safety, do away with resident engineers, simply as such. The case is, however, far different, and we cannot but think such a step to be a very short-sighted and ill-advised one.

It would not be a difficult task to pick out a road where the permanent way was in bad order, bridges out of repair, masonry neglected, and things running down generally, not because sufficient money was not spent on repairs, but because lack of intelligent and comprehensive supervision caused it to be wasted. A good resident engineer, after a few years hard work, would systematize the work and the accounts, put material where it is wanted, at the least expense and at the right time, (for we know how, on a permanent way, "a stitch in time" is particularly needed), see to it that the supplies were purchased in season, and not when an inconvenient time gave rise to an increased cost, did not have a quantity of timber or other material stored on one part of the road and then more bought for another place, and, in short, put matters in such trim that they seemed almost to run themselves. Then the directors think that he has little to do, and that his duties can be as well performed by other and probably cheaper labor; they abolish the position, save the few thousand dollars of salary, and apparently all goes well. But unless the charge of these matters has been put into competent hands, which is seldom the case, the permanent way will begin slowly to deteriorate, until the deficiencies become so marked that a new resident engineer is called in. He begins the same up-hill journey of improvement that his predecessor traveled, and the expense to the company is far more in the total than the aggregate of yearly outlay would have been under the old regime.

Doubtless our engineering readers agree with us in these views, so that the expression of them will hardly be of benefit, unless, perchance, they may reach the eye of some railroad officers who are casting about for some way to curtail operating expenses. If so, we would recommend them not to cut off the engineers. We are reminded of cases, somewhat parallel, where municipal corporations have been moved to dispense with the regular services of a civil engineer, calling upon one by the day, or otherwise, whenever they, in their best judgment, thought that he was needed. At other times the work was conducted and repairs made under inferior superintendence. A true balance sheet for the year never showed any economy in dollars and cents, but always the reverse.

We notice that Mr. L. H. Clarke, late the chief engineer of the Illinois Central R. R. has taken a similar position on the Lake Shore and Michigan Southern R. R.

A portion of the roof of the new Post Office in New York fell on May 1. A brick cross-wall which had previously supported a portion of the roof had been cut away and an iron truss had been substituted, timber struts meanwhile having been used to support the superincumbent weight. On the completion of the work and the removal of the timbers, the truss immediately yielded under the load and some 20 feet by 30 feet of the roof fell in, burying four of the laborers in the ruins, and causing the death of three of them. The truss was supposed to be similar to another already in use, and to be as strong. The roof was made of iron beams, carrying arches of corrugated iron, leveled up with concrete and thus protected on the outside with sheets of copper, thus making a fire-proof roof. The concrete was some three inches thick on the crown of the arches, upwards of a foot thick at their springings, and the whole weight is stated to have been 100 pounds per square foot.

As the coroner's jury did not commence their sessions, until Monday, we have not, at the present writing, obtained any information as to the cause of the failure. The jury is composed of four architects and eight practical builders and masons, so that we may hope for a satisfactory explanation of the matter, and will wait for their verdict, in place of giving the surmises and theories of Mr. Mullett or the supervising architect.

CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SECOND DAY.

NEW ORLEANS, *April 25, 1877.*

The meeting was called to order by the Chairman, Prof. Forshey, at 10 A. M.; and after the names of the members and guests who arrived by the morning train were registered, W. Sooy Smith, Chairman of the Committee of Iron and Steel, read the report of that Committe.

After reading the report Gen. Smith gave a brief account of the creation of the Commission on Tests of Iron and Steel, and what it had accomplished. He also alluded to the antagonism of the Ordnance Department and the indifference of Congressmen towards the Commission and its purposes, and in closing he earnestly solicited the co-operation of every member of the Civil Engineering Societies of the country in presenting the subject in its true light and importance to their representatives at Washington. He declared that the Commission could not go a step further without the aid of the society, and the society must work if it would effect anything in time. The time for which the Commission was constituted would terminate this year and therefore if anything was to be done, it must be for the action of next Congress. The speaker in the course of his remarks alluded to Hon. Abram Hewitt in anything but flattering terms, and closed by urging the importance of the subject and that the society in its present meeting take active measures for securing the continuance of the Commission, and the obtaining funds for the prosecution of its experimental labors.

Major Farquhar protested against the attack on the Ordnance Department and remarked that if its side of the story could be heard, it might present a different phase of the question. He also explained that according to the laws of the United States the government funds must be dispensed by its duly commissioned servants.

Clemens Herschel considered it disgraceful that *something* should not result from the money and labor already expended by the Commission, and moved that a committee of three be appointed to draft a series of resolutions to be presented at this convention, such as the exigencies of the case demanded.

The Chair appointed Messrs. Griffin, Bouscaren and Philbrick as that committee.

Mr. Emery hoped that the discussion of the subject would be general, as its importance demanded action prompt and efficient. He remarked that the question is, "Shall the whole matter be put in the hands of the Ordnance Department or shall it be shared with the Civil Engineers Society." There are other than government needs to be considered and it is but a small part of the public works of the country upon which the military engineers are employed.

Government officers consider permanence more than economy in construction and to them the importance of a thorough and accurate knowledge of the qualities of American iron and steel are not so great as to civil engineers who are engaged in bridge building and in other public works throughout the country, and who, while fully realizing the paramount importance of safety and permanence in construction, have also to consider the subject of economy in the use of materials, and who having adopted a sufficient factor of safety did not wish to add to the load by an excess of material. He suggested that an intermediate course be pursued and that the military engineers act as chairmen while the civil engineers take that part in the investigations to which they are justly entitled.

Some further remarks upon the subject were made, and it was suggested that all scientific societies in the country be invited to partake in the discussion, and use their influence in promoting the success of the Commission.

The Chairman announced the programme for Thursday. Gen. G. T. R. Beauregard was then introduced to the Convention and in a neat little speech welcomed his fellow engineers to New Orleans and hoped they would find their visit a very pleasant and profitable one.

E. L. Corthell invited the Convention to visit the jetties at South Pass on Friday. He stated that Capt. Eads, and Mr. Andrews, the contractor, would furnish a steamer for the trip, which would take two days to accomplish, and that the only expense to those going would be for meals while on board. One representative of each of the daily papers of New Orleans was invited to accompany the party to the jetties; the ladies also were invited. A committee consisting of Messrs. DeFuniak, Vaughan and Hardee was appointed to invite others than members of the Convention to visit the jetties with the party, on Friday.

City Surveyor J. E. D'Hemecourt presented to the Society a plan drawn by Gen. Buisson, in 1830, to open a channel from the Mississippi River to the Gulf of Mexico, which would permit vessels drawing 25 feet of water to pass through, which was accepted with the thanks of the Society.

The following was introduced by the committee appointed for the purpose:

WHEREAS, in 1872, a committee was appointed of members of the American Society of Civil Engineers to take into account and to ascertain the best way of establishing a Board for the testing of such metals and alloys thereof as form parts of such structures and machines as are required for the use of this country, and

WHEREAS, in pursuance of such appointment the committee proceeded in their labors, as far as to obtain favorable action from the Congress of the U. S., not only in a law authorizing the creation of a Board for the purpose of making such tests, but also appropriated

money to be expended by said board in the purchase of the necessary machinery, and in the making of such tests, and

WHEREAS, at a late session of Congress a law was passed by which said board would cease to exist on the expenditure of the money thus appropriated, now therefore be it

Resolved, This Society declare the tests proposed to to be made to be of national importance, they therefore ask that so much of the sundry civil appropriation bill passed by Congress, as provides that the board to test iron, steel and other metals, shall be discontinued when the money appropriated for its use by the same shall have been expended, be repealed, and that the unexpended balance in the hands of the board shall be re-appropriated and such other appropriations made for the use of the board as it may require to complete the investigations it has undertaken. The sum required for the coming year being $40,000.

Resolved, That every member of this Society be urged to use such influence as he may possess to obtain favorable and immediate action by the Congress of the U. S. in furtherance of the object here prayed for.

Resolved, That the above resolutions be printed and that each member of this Society be furnished with several copies to be used in furtherance of the object sought and that reports of their action in the premises shall be made by the members to the Secretary, giving the names of each member of Congress as have been seen or addressed on the subject.

E. S. PHILBRICK,
JNO. C. GRIFFIN,
G. BOUSCAREN. } *Committee.*

The Convention then adjourned. At 7 P. M. it was again called to order and the following committee on Nominations was appointed: W. S. Worthen, N. Y.; W. Sooy Smith, Ills.; F. De Funiak, Ky.; J. P. Wilson, Penn.; C. F. Forshey, La.

Prof. Forshey read a paper giving an account of some of his own inventions and patents; some of the former were very remarkable indeed, and when tested we hope to be present.

Mr. Hardee gave a description of a method adopted by him in running a line of levels over the New Orleans and Jackson Railroad, a distance of 400 miles in eleven days, an average of over 36 miles per day, with three negro assistants, and a hand-car.

Mr. Bouscaren illustrated the method of building the Kentucky River Bridge on the Cincinnati Southern Railroad, by means of a diagram on the blackboard. A vote of thanks was tendered to Prof. Forshey for the efficient manner in which he had presided over the meetings. The Convention then adjourned *sine die*.

After the adjournment Capt. Cowden exhibited maps and profiles of the Barrataria Ship Canal and an invitation was given to the members present to accompany Capt. Cowden, free of all expense, over the proposed route of the canal.

THURSDAY, APRIL 26.—THIRD DAY.

At 9 A. M. a large number of the members of the Convention assembled by invitation on board the Underwriters' Iron Fire Boat "Protector," for the double purpose of viewing the levee and water-front of New Orleans, and of inspecting the fire extinguishing apparatus on board the boat. The "Protector" is an iron steamer of 150 tons register, owned by the Board of Underwriters of New Orleans and used solely for purposes of harbor protection. She was built in 1875 by the Harlan and Hollingsworth Company, at their yard upon the Delaware River, and is thoroughly fire-proof. With a 250-horse power engine and a faultless model, she is capable of a rate of speed which is simply astonishing, but is very necessary for her speedy transition to any point along the river front in case of fire. She is provided with most powerful engines for the purpose of throwing water directly upon a fire, in case of such disaster among the steamboats and shipping, and for pumping water into the open gutters, through a 16-inch hose, when a fire occurs on land in neighborhoods into which the pipes of the waterworks do not extend. Besides these, the "Protector" is furnished with the new appliance for forcing carbonic acid gas into a vessel's hold, called the "Carbonic Acid Gas Ship Fire Annihilator," an invention of Capt. A. M. Granger, the energetic and indefatigable agent of the Babcock Fire Extinguisher Co. in New Orleans, who has patented his appliance, and whose zeal in the prevention of loss by fire we hope may be rewarded with commensurate pecuniary success.

Capt. Granger's invention relates to certain improvements in chemical fire-extinguishers, designed more particularly for harbor fire-protection boats and sea-going vessels, but applicable also, in most of its features, to general use.

The general principle of the improvement rests in the direct use of the dry gaseous carbonic acid in smothering volume, in contra-distinction to the common use of a limited quantity of the same dissolved in water under pressure.

The means for carrying out the invention consist generally, in the combination of a set of capacious generators for containing bicarbonate of soda, a set of superposed acid-vessels, a subjacent acid-reservoir, and an air-pump, or equivalent forcing apparatus for charging the acid-vessels from the reservoir, the whole being combined by means of communicating pipes, controlled by valves or cocks, so that the acid may be forced from the reservoir in the hold of the boat only when the effective power of the gas is required, and whereby accidental admixture of the chemicals is, from the motion of the vessel or from other causes, completely avoided.

The apparatus is placed in the stern portion of the vessel just aft of the engine room, and occupies but little space. It consists of three copper tanks, filled with oil of vitriol, each of which connects with lower tanks capacitated for 180 gallons each, which, when exhausted or rather as they exhaust, are refilled from connecting tanks between decks. These lower tanks each contain 448 pounds of bi-carbonate of soda, which is dissolved in water. In front of the tanks connecting pipes run so as to admit of turning them all on at once or separately, as the occasion may require. Attached to and leading into each tank of those between decks is an endless chain, arranged something like a well pump, which is constantly turned while the extinguisher is in operation, thus stirring the soda and water to mix it thoroughly. Every tank is provided with a safety valve and indicator, which, when the cock is turned, permitting the vitriol to descend into the soda water, shows exactly the amount of gas generated. These extinguishers will generate about 60,000 cubic feet of carbonic acid gas, and hence the introduction of this proportion of gas into a space of 400,000 cubic feet of air will more than extinguish any fire, as where 15 per cent. of carbonic acid gas exists, combustion cannot. This apparatus is especially designed for the purpose of extinguishing fire when it occurs in the hold of a vessel where the gas can be confined by battening down hatches.

For fires on deck and in open places, attached to the gas apparatus are two other tanks constructed on the same principle, which, however, throw a strong liquid solution of sulphuric acid and soda.

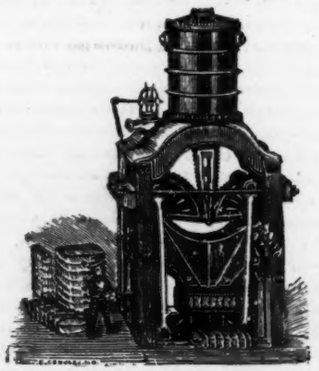
This apparatus has been tested experimentally many times, and has also been put to practical use in saving already some hundreds of thousands of dollars worth of property for its owners, by subduing fires on board three cotton laden vessels in the harbor of New Orleans. There is no doubt that Capt. Granger has effected a revolution in the method of extinguishing fires on shipboard, and we expect to see his apparatus made use of in all the large and crowded harbors of the country before many years more.

The "Protector" steamed first to the Government dredge boat "Essayons," lying on the Algiers side of the river and after a pretty thorough inspection of that "mud stirrer" the party were conveyed rapidly by the gallant tug up the river, past the dry docks, past the long line of river steamboats, and the longer line of sailing vessels and iron steamers lying at the wharves in waiting for cargoes, coming to her landing place just astern the U. S. Coast Survey steamer. While one portion of the company witnessed the working of the Fire Extinguishing Apparatus, of the efficiency of which a most satisfactory test was given by Capt. Granger, another and considerable portion of the crowd had taken most unceremonious possession of the deck of the survey boat, and were being made acquainted with the several appliances for deep sea sounding, testing the temperature of the water at various depths, determining the nature of the bottom, etc., etc., through the politeness of the officers of the survey on board, who addressed themselves at once to the entertainment of their unexpected visitors. After a very pleasant and profitable half hour spent at this point the party, once more on board the "Protector," were taken farther up the river to the works of the Louisiana Ice Company, where they were landed and from whence the tug at once returned to the city.

The extensive works of the Louisiana Ice Co. have been in operation about five years. The ammonia process is used, and the product varies from about 65 tons per diem in the summer time to 84 tons in the winter. In all about 50 men are employed. The ice is produced in slabs 2½ inches thick by 9 inches wide by 24 inches long; a considerable percentage is lost by melting on account of the size of the slabs, but the company were building a machine for pressing the slabs together so as to form cakes of considerable size and thus reduce the wastage. A great deal of interest was taken by all the visitors in the different stages of the conversion of the muddy fluid from the adjacent Mississippi, to the beautiful slabs of pure crystal which about three hours of chemical and mechanical manipulation produced. In another column we have taken the opportunity to publish a portion of the discussion upon a paper read before the Institution of Civil Engineers, upon the "Mechanical Production of Cold," which we thought might be of especial interest at this time to those of our readers who were of the party to the New Orleans Ice Factory. We may observe, before taking our leave of this part of our subject, that the establishment and operation of this factory has reduced the price of ice in New Orleans from $60 per ton to $12, at which it is now selling.

While most of the engineers had been enjoying the sights which we have described, another party under the leadership of Prof. Forshey had been visiting some of the large cotton warehouses for the purpose of seeing the work of the presses. The raw cotton after being subjected to the action of the "gin" is pressed and baled in a loose sort of way at the clumsy wooden plantation presses, and in this shape is delivered on the levee at New Orleans. It is thence hauled to the various improved presses, of which there are several conveniently located near the levee, and after being subjected to the pressure of these ponderous machines, thereby reducing the size of the bale very materially, is ready for shipment to other parts.

We present here an illustration of one of the best styles of cotton press in New Orleans. It is on the Tyler principle, with improvements by a Mr. Morse, of New Orleans, by which fifty per cent. is added to its economy and effective power. We had the pleasure of seeing one of these presses at work, and, so far as we were



able to judge, it seemed hardly possible to improve on the easy and rapid manner with which it performed its ponderous work. Mr. Morse claims for his invention, that the shape of the rack and sections as shown in the cut, gives a progressive and immense leverage so that nine powers are practically attained, enabling the press to do better work with 80 pounds of steam pressure than others with 120, thus saving ten to fifteen dollars in full per day. It has a capacity of 75 to 100 bales per hour, which at 75 cents per bale ought to yield a very fair profit to the factor.

From the ice factory the united parties proceeded by horse cars to the city terminus of the Carrolton railway, where they were hauled by the well known fireless locomotive to Carrollton, a distance of about three miles. At this point the party witnessed the charging of the locomotive with superheated steam, and also visited the levee close by, where Prof. Forshey, who is supposed to know "all about levees and the Mississippi river generally," gave the party the benefit of his familiar acquaintance with the great "Father of Waters." Having disposed of very nearly the entire stock in trade of the solitary vender of fruit, pies, and villainous fluids, at the Carrolton depot, the majority of the party betook themselves to the *elegant* vehicles which had been provided for their transportation to the drainage works, cemete-

ries and such other points of interest as the programme had specified, and from whence they returned to their hotel with the conviction that the ancient city of New Orleans needed drainage, sewerage, water-works, and public works generally, and that evidently there was work for civil engineers to do there before many years.

A special train landed the party at the Lake Pontchartrain hotel shortly after 7 P. M., and the continuous journeying of the entire day not having whetted their appetites sufficiently the whole company strolled leisurely down the half mile wooden causeway to the lake, looked at the light-house, speculated upon the length, breadth, depth, height, flavor, and other qualities of Lake Pontchartrain, and then strolled back again to dispose of that part of the programme entitled the "Convention Dinner." About 75 persons, ladies and gentlemen, sat down to the tables, which were well arranged and tastefully decorated with a profusion of flowers. New Orleans is noted as a fish market and the bill of fare of this banquet was largely of fish. Everything connected with the evening's entertainment was in most excellent taste and reflected great credit upon the committee who had charge of the matter. Engineers are not noted as after-dinner speech makers, and so we shall not attempt to reproduce the wit and wisdom of this happy occasion. The train took the party to the city at 11 P. M., and we do not well see how there could have been any headaches the next morning from the effects of the evening's hilarity.

The grand excursion of the occasion—the trip to the jetties at South Pass—left New Orleans the next morning at 10 o'clock, and next week we propose to give our readers a full account of that most delightful journey.

ON THE MECHANICAL PRODUCTION OF COLD.*

BY ALEXANDER CARNEGIE KIRK, ASSOC. INST. C. E.

By the mechanical production of cold as distinguished from cooling by radiation or conduction, the author would in the following paper, be understood to mean the removal of heat from a body by a continuous circle of mechanical operations, without the use of anything colder than the body it is desired to cool. He will chiefly confine himself to a description of apparatus, in which the medium used is an incondensable gas such as atmospheric air.

Every machine for producing cold, under the conditions stated, is simply the negative solution of a motive-power heat-engine. A motive-power heat-engine absorbs heat at a high temperature, rejects it at a lower temperature, and develops an amount of power in proportion to the number of degrees through which the temperature falls. A machine producing cold is such an engine, absorbing heat at a low temperature rejecting it at a higher temperature, and requiring work to be spent in driving it in proportion to the number of degrees through which the temperature is raised. Heat in falling from a high temperature to a lower temperature exerts "work;" and "work" has to be expended to raise a low temperature to a higher temperature. The thermo-dynamic formulæ for every heat engine apply equally to the corresponding refrigerating machine; the work in the former appearing as a positive, and in the latter as a negative quantity. It is a condition, equally of a motive-power engine and of a refrigerating machine, that the temperature at which heat is rejected should be high enough to be abstracted by surrounding bodies—in practice water; and thus this temperature is much higher in tropical countries than at home. The most familiar motive power engine, the steam engine in its most complete form, becomes a refrigerating machine, the water in the boiler being evaporated nearly in vacuo, and condensed at something over the atmospheric pressure. Harrison's well-known ether machine is the same; ether being substituted for water on account of its lower evaporating point, by which temperatures as low as zero in the Fahrenheit scale can be reached. This may serve as an illustration of machines for cooling purposes in which condensable vapor is used.

Similarly, any engine, such as Ericcson's air engine, or Stirling's, using an incondensable gas may become a refrigerating machine; expansion by heat and compression combined with cooling serving the same purpose as evaporation and condensation in the former case. The first has been often tried as a practicable refrigerator.

* Paper read before the Institution of Civil Engineers, London.

[The paper is a long one and being illustrated cannot at present be reproduced in full by us; we therefore quote only some parts of the discussion which followed its reading.]

Mr. Siemens said if he wished to be critical he might find fault with the title of the paper. The author spoke of a machine for "the production of cold." Cold was the absence of heat, and it might be open to question whether it was possible to produce the absence of a thing. Refrigeration, which he thought the preferable word, meant the transfer of heat from one substance to another of the same or a superior degree of temperature, and the author evidently agreed in that definition. The subject was one of considerable interest at the present time. Refrigerating machines were now largely used in breweries, since fermentation went on to advantage only at a temperature a little above freezing point; and to attain that point during all seasons of the year rendered artificial means of maintaining a low temperature necessary, unless native ice was employed for the purpose. For preserving meats also in hot climates and transporting it, artificial means of reducing the temperature were coming into use, and would be more extensively employed if a cheap and ready method could be devised. Refrigeration was of great importance in hot climates in a sanitary point of view, and the time was not distant, he thought, when houses and places of public resort would be refrigerated with the same care and regularity as they were now heated when necessary. He believed this might be accomplished at a cheap rate. It was stated in the paper, and it was an undoubted scientific fact, that mechanical refrigeration might be obtained at a cheaper rate if the reduction of temperature required were only slight than if it were considerable. Thus, an air-machine producing ice would work much less economically than one producing only cool air. In order that the subject might be more fully opened out for discussion, he proposed to refer shortly to the different methods that had been devised for producing refrigeration. There were four methods in use. The first was the old system by the evaporation of alcohol, ether, or other volatile substances. Even water when allowed to evaporate under a current of air produced refrigeration. Alcohol did so to a greater extent, and ether to a still greater extent. This method had been adopted, perhaps for centuries; but in recent times it had been improved by Siebe and by Harrison, who had contrived that the vapor produced by evaporation should not be lost, but that it should be mechanically compressed and condensed, in order to serve over and over again. The method of producing the reduced temperature was the same in both cases, but instead of losing the ether or alcohol, a certain amount of power was expended in the improved arrangement. Another method was the chemical one of producing refrigeration by evaporation in connection with absorption. Many vapors—ammonia being one of them—were readily absorbed by water, but could be separated again by the application of heat to the mixed liquid. A machine on that principle was shown at the Universal Exhibition, in 1851, by M. Carre, and very good results had been realized by it. It consisted of a boiler which was filled with ammoniacal liquor, and the ammonia vapor was driven off under considerable pressure into a surface condenser composed of tubes surrounded by cool water. A separation was thus effected by heat of the ammonia from the water; and the ammonia, after being withdrawn into a vessel of lower pressure, evaporated at a very low temperature, and thus produced refrigeration, the vapors of ammonia being eagerly absorbed by water of ordinary temperature forming mother liquid for re-evaporation in the boiler. The machine was largely used, especially on the Continent; and, from information he had received, it produced a hundredweight of ice at the expense of about a shilling. An ingenious modification of this machine for small applications on board ship or for household use had been devised, consisting of two vessels connected by a pipe, but hermetically sealed. One of the vessels contained the mother liquid, which was alternately heated and cooled, to drive off the ammonia, and to re-absorb it from the second vessel, which served alternately as condenser and refrigerator for the production of ice. Another method was by the solution of crystalline substances. There were various refrigerating mixtures, one of the salts so employed being carbonate of ammonia, and another chloride of calcium. When crystals of chloride of calcium were dissolved in water, a considerable reduction of temperature—about 30° Fahrenheit—took place. Although that would not be sufficient to produce ice from water of 60° or 65° temperature, an arrangement could be made by which the water to be cooled exchanged heat with the spent liquor, thus producing an accumulation of the effect in the center of the machine. He constructed a machine on this principle many years ago, which produced ice at a considerable rate, but the salt employed—chloride of calcium—was not a pleasant substance to deal with. It had to be re-evaporated and crystallised, and this process was inferior to the purely mechanical methods which had since been adopted. The most perfect of these, as regarded cleanliness and freedom from loss, was the air machine. Atmospheric air was compressed to one-half or one atmosphere above atmospheric pressure. The compressed air was allowed to cool in contact with water, either by external application or by injection, and to expand again in a working cylinder. The amount of heat that disappeared in the second working cylinder was the exact measure of the refrigeration produced, and it could be easily calculated; whereas the power expended was the difference of force involved in compressing the air at a higher and of expanding it at a lower temperature. In 1857 a machine of that description was invented by Dr. Gorrie, an American, and was brought to London. Mr. Siemens was asked to report upon it. The machine did not produce satisfactory results. The engine was a good one, and the air-pump was judiciously constructed; but the connection between the reservoir containing the compressed air and the air-expansion engine was too narrow, and was provided with a throttle valve, there being evidently a vague idea in the mind of the inventor that the air would produce more refrigeration in expanding spontaneously without doing work than in expanding behind a working piston, an idea which was permissible at that time when the dynamical theory of heat was little understood. That was one of the defects which he pointed out. Another was that the hot or compressed air was not sufficiently cooled before it was expanded, and was not deprived of its moisture. The moisture in air played a considerable part in those machines. At a temperature of 65° Fahrenheit saturated air contained 1 per cent. of vapor of water, and this had not only to be reduced into the liquid, but also into the solid condition representing a total absorption of heat to the amount of 1,140 units of heat per lb. of condensed vapor, which upon the quantity of air, would represent 15° Fahrenheit of loss in the effect produced by the expansion. He believed, if these faults had been remedied, the machine would have given satisfactory results. Since that time a German engineer, Mr. Windhausen, had constructed machines on similar principles, and had, after many fruitless attempts, obtained remarkable results. It was stated, at a meeting in connection with the Vienna Exhibition, that a machine of 150 H P. produced 30 cwt. of ice per hour, the theoretical result being that that amount ought to be produced by 90 H P. The cost of producing a hundredweight of ice by this machine was stated to be one shilling—a similar result to that obtained in M. Carre's machine. The machine described by the author of the paper was also an air machine, a reversed air-engine, so to speak, and therefore, in a certain sense, analogous to those he had before mentioned. The author did not compress the air, cool it, and then transfer it into a separate cylinder to be re-expanded, but he combined these operations in an engine similar, in every way, to Stirling's air-engine, on a supposition that that was the most perfect air-engine known, and that, in inverting it, he would be likely to obtain the best result of refrigeration. He could not, however, agree in the opinion that the Stirling engine was a perfect one. It was the first engine containing a regenerator; but (as he had pointed out in a paper read before the Institution in 1853) it realized, at most, only from one-fifth to one-sixth part of the theoretical duty of the heat expended. The reason was that all the air cooled and heated alternately, did not enter the working cylinder; but the diagram of the force obtained in the working cylinder formed only a sixth part of the diagram that would be produced if the whole of the air were allowed to expand behind a working piston and between the same limits; and that proportion really indicated the dynamic value of the engine.

Therefore, although he admired the ingenuity with which the author had enlarged the available heating surfaces of Sterling's arrangement, and elaborated the best form of regenerator for the purpose, he could not agree in the application of that principle to refrigeration. He believed better results would have been obtained if the compression apparatus had been separated from the expanding apparatus as had been done by others. That opinion appeared to be corroborated by the results given in the paper. With 37 HP. twenty gallons of water were reduced from 61° to 47¼° per minute, which was equal to 2.8 lbs. of ice per hour, whereas the Windhausen engine was said to produce 20 lbs. of ice with 1 HP. Generally speaking, he believed the air-compression engine, on the purely mechanical mode of producing refrigeration, was applicable with the greatest advantage where moderate refrigeration was required. Where the production of ice in large masses was desired, he believed the method adopted by Siebe and by Harrison was superior, for this reason: in compressing and produce the effect of 1 lb. of ice; whereas in compress-expanding air, 25,000 cubic feet of air were required to ing sulphuric ether after evaporation, only 5,100 cubic feet were required, the reason being that when sulphuric ether was transferred from the liquid into the gaseous condition, the whole of the latent heat was obtained. A much higher result was arrived at by using a still more volatile substance—methylic ether—which at a depression of temperature equal to 15° Centigrade had a pressure of 1½ atmosphere, and the displacement of piston to produce the same effect was only about 340 cubic feet. Therefore a pumping engine, with a displacing capacity of piston of 340 cubic feet per minute, would produce the same effect as an air engine of 25,000 cubic feet displacement per minute, and of 5,000 cubic feet in the case of a sulphuric-ether engine. This meant a much smaller engine and a less costly machine in the case of the methylic ether pump, although the expenditure of power might be the same; but on the other hand, there was the set-off of having to deal with a highly inflammable material like methylic ether instead of with atmospheric air. For producing a depression of temperature in houses or breweries he believed the air-engine was the best contrivance that could be adopted.

Mr. Rees Reece said the machine devised by the Author was the most complete one of its class yet constructed; but he now came to another method of applying cold, independent of mechanical power. All that was required was to burn a given quantity of coal under a steam boiler, and the energy produced by that coal was the whole energy required. Mr. Philip Ferdinand Carre, fourteen or fifteen years ago, when engaged in the construction of ether machines, finding it difficult to carry them through, was led, after some researches of M. Regnault, to construct an ammonia machine. Mr. Carre took a quantity of strong solution of ammonia, and boiled it over and into a condenser. He found, as others had done since, that 100 lbs. of strong solution of ammonia, boiled by a distillation up to 5 per cent., yielded 75 per cent. of ammonia, and 25 per cent. of water. This being condensed would be used effectively for refrigerating purposes. The only drawback was that the liquor condensed contained 25 per cent. of water, and holding a large quantity of ammonia made the machine intermittent and relatively costly, but not nearly so costly as an air or ether machine as a method of producing cold. The French Academy appointed a commission to investigate the subject, and that commission pointed out the want of complete success in the machine, stating that what was required was a method by which ammonia could be had nearly anhydrous on one side, and an exhaust liquor on the other free from ammonia. This led him to study the problem, and he would briefly state what he had done. By mixing two liquids together of different boiling points, one liquid could be separated thoroughly and perfectly from the other. When alcohol was mixed with water up to 5, 10, or 20 per cent., by a process of fractionation, the two could be separated; and it occurred to him that he could thoroughly remove the whole of the water contained in the mixture, and obtain on one side of the instrument ammonia free from water, and on the other side water comparatively free from ammonia. This he had been enabled to do, and the ammonia obtained in this way, passing through a condenser without the aid of any mechanical energy, was condensed simply by its own accumulation, and a current of cold water passing round it. Passing that ammonia into a refrigerator, he connected it to an absorbing vessel containing water or exhaust liquor; and simply opening a cock connecting them was sufficient for it to resume its aeriform condition, without the aid of any mechanical force, the gas being removed by its solution in the liquor of the absorbing vessel. In the case of the ammonia, the same as the ether, a portion of the work of the refrigerator was to reduce the temperature of the ammonia from that of the condenser to that of the refrigerator at its working temperature. Instead, as in the case of the ether, using from 14 per cent. to 30 per cent., he found, in reducing it to 41° he had used 2½ per cent., in reducing it to 14° 4 per cent., to zero 5 per cent. For every lb. of ammonia thus liquefied in the liquefactor, 920° of heat were given out, *i. e.*, it heated 920 lbs. of water through 1°. In the evaporation of the same quantity of ammonia it cooled down 920 lbs. of water through 1°. At whatever temperature it worked the cost of refrigeration was the same; by means of ammonia, therefore, cold could be produced at the cheapest possible rate. The relation existing between ammonia and ether was the relation between 168 and 920, irrespective of the mechanical energy required. There was one other advantage in the use of ammonia. When the temperature of the cooling cylinder was reduced 30 below zero, it had still a mechanical energy and force equal to that of water at 212, and going down further, 10, 15, 20, 30, 40, 50, and even a temperature of 60 degrees below zero of Fahr, it would be as energetic an instrument as at any higher temperature, whilst all others deteriorated in efficiency as the temperature fell. Taking a pound of coal and burning it clean under the same boiler, 8,500 heat units would be transmitted to the water. Using that to work a good air machine, 200° of heat would be absorbed; in the ether machine, 600°; in the ammonia machine, 4,000°. These differences showed the real economy of the different systems. It was essential that the machines, whatever system was adopted should be well constructed. * * * * *

Mr. Bourne observed that it would be an invidious task to pronounce upon the rival pretensions of the different freezing machines of which the characteristic features had been expounded; but it might not be inopportune to offer a few general remarks on the subject of refrigeration.

Cold was produced by radiation into space, by the liquefaction of solids, by the vaporisation of liquids, by the dilatation of gases, and by electricity.

In the upper provinces of India ice was obtained by exposing water, in shallow porous vessels, to the cooling influence of the sky during clear nights. The evaporation from the porous vessels cooled down the water, and the radiation of heat from the surface produced a film of ice, which in the morning was skimmed off and preserved for use. It was a necessary precaution to place the vessels upon a layer of straw, so that they might not be affected by radiation or conduction upward from the earth; and it was also indispensable that the sky should be free from clouds, else the heat was radiated back from the clouds, and freezing did not take place. The operation of the same laws occurred in the deposition of dew. The surface of the earth was cooled by radiation, and the moisture of the air was condensed by the cold surface and precipitated as dew, in the same way in which moisture was precipitated upon the surface of a glass of cold water in summer, or upon the windows of a heated room when the air outside was cold.

If ice at 32° was heated over a fire, it would take some time to melt, although it had all the while been receiving heat, and although the resulting water was still only at a temperature of 32°. This showed that melting absorbed heat; and when the heat was supplied from any extraneous source the liquefaction was a source of cold. Thus when certain salts were melted in water cold was produced, and those salts were called freezing mixtures. So also a low temperature resulted when snow and salt were melted by being mixed together.

The vaporisation of liquids was one of the usual ways of producing cold. In India water was cooled by pouring it into a metal bottle, which was then wrapped in a wet cloth and swung in the sun. The heat and current of air induced rapid evaporation, which cooled the contained water. When the hot winds prevailed in the arid parts of India, houses were cooled by blowing air through a thick matting kept constantly wetted with water. The evaporation of the water cooled down the air to an agreeable temperature, and the hotter the wind the greater was its avidity for moisture, and the greater the refrigeration.

The dilatation of gas, as well as the evaporisation of liquids, afforded a powerful refrigerating agent, and one or both of these expedients was called into play in the different freezing machines. In Mr. Kirk's machine atmospheric air was the gas employed. The air was compressed by a piston, by which means the temperature was raised, as in the syringe for lighting amadou tinder by the sudden compression of air. The heated air was cooled by water, and was then suffered to expand, when it sought to recover from surrounding objects the heat it had lost, and thus lowered their temperature.

Electricity was a source of cold not yet developed, but which appeared worthy of attention. More than thirty years ago Peltier, in experimenting on the thermo-electric battery, discovered that cold was produced by a current passing from the bismuth to the antimony. All the freezing machines described in the course of the discussion were virtually thermo-dynamic engines inverted. Such engines uniformly worked with a great loss of effect; and the efficiency of electro-magnetic engines was about four times greater than that of heat engines. A similar relation might, perhaps, hold in the inverted machines.

In all thermo-dynamic machines there must be two temperatures, just as in the generation of power by gravity there must be two levels, and in the subsidence of the weight from the higher to the lower level power was generated. In freezing machines there was only one temperature to begin with, and that had to be raised at one end of the machine, or to be depressed at the other end, by an expenditure of power, just as power had to be expended in winding up a weight. It was a law of thermo-dynamics, that the same quantity of heat, with the same extremes of temperature, would generate the same amount of power, whatever might be the medium through which the heat was made to operate—whether it was steam, or air, or water, or metal, or any other substance. The converse of this proposition would also be true; and just as a given expenditure of heat would produce a corresponding amount of power, so would a given expenditure of power produce a corresponding amount of refrigeration. Excluding details, therefore, and without entering into minutæ, there was no theoretical reason why one freezing machine should not be as efficacious as another. The difference between them was not so much a difference in principle as a difference in cost, or convenience, or safety or something of that nature. As heretofore constructed, the air machine appeared to absorb more power to do the same work than some others; but this result he considered accidental to the mode of construction adopted, and that it might be obviated in future examples. If, in point of cost, all the systems were made equal—which he believed to be the inevitable tendency—then the question of comparative merit would narrow itself to considerations of safety and convenience. He could not assent to the remarks of one of the constructors of ether machines, as to the visionary nature of the apprehensions entertained in regard to the danger of ether, especially on board ship. A system of supplementing the power of steamers by the employment of ether was, some years ago, proposed by M. Du Trembly, and this system was applied to several steamers by the late Mr. J. W. Jameson, Assoc. Inst. C. E., who had read a paper on the subject before this Institution, and who had referred to some of the accidents that had occurred. He did not maintain that the risks of using ether in freezing machines on shore were as great as those arising from its use in engine-rooms at sea; but he thought that all vapors, like those of ether or ammonia, which were inflammable or poisonous, and liable to leakage under high pressures, were objectionable on shipboard, whereas atmospheric air was harmless. He believed, too, it was on board ship that one of the most valuable applications of the freezing machines would yet be found—in enabling frozen meat to be brought from all parts of the world in vessels specially constructed for its conveyance.

THE TOPOGRAPHY AND DRAINAGE OF NEW ORLEANS.

BY THOMAS S. HARDEE, CITY SURVEYOR.

(Concluded from page 114.)

One difficulty about the location of the present draining machine is, that they are near the inhabited portions of the city, and with so little fall in the drains leading to them as at present constructed, that after a heavy rain-fall, and before the machine can be set in motion, the closed gates of the draining machines, together with their side levee, form such a dam or barrier, that the tendency must be to back the accumulating water far up into the front limits of the city before relief can be obtained.

An additional difficulty, too, which now practically exists, and which contributes more than anything else to delay the proper relief, is the want of capacity in the present street gutters and other drains for conducting the water fast enough to the main drainage or reservoir canals. Owing to these combined difficulties, it is not infrequently the case during a heavy rain that on some of the most populous thoroughfares, people are kept waiting for hours before being able to cross the streets.

By the transfer of the draining machines to the points designated, these difficulties must be provided for and can be overcome, and the inferior dam or barrier alluded to will have a substitute in the lake shore revetment levee, which being so remote, and having behind it so extensive a reservoir as contemplated, will offer no obstruction whatever to the free and rapid outflow of all water from the front. By this new system, also, the use of long tail races will be abolished, and the water will be forced by simpler process at E, F, and G immediately through the revetment levee into the lake, and at H through the protection levee into the adjacent swamp. By the present system the machinery is unduly taxed to wash the inside water through a long column represented in volume by the cross section and length of the tail race, and this too before the water to be discharged can reach the distributing surface or level of the lake.

The lake shore revetment levee, a part of which is completed, will be made from the excavations of a canal about twenty feet deep and sixty feet wide, and as it is located several hundred yards from the lake shore, where the water is about three feet deep, it will be readily conceived what an extensive basin or reservoir this canal and surroundings will afford for the reception of water.

It is expected that the new draining machines in the interim between rains will keep the surface water in the contiguous canals reduced to a point six or eight feet lower than what it now is relatively at the present draining machines, and this will, of course, greatly increase the plane of inclination of all interior canals leading thereto, and consequently augment the flow of water to the points of drainage. When this result is accomplished, it will follow that a system of underground sewerage can be successfully established, which will abate the present nuisance of open drains and canals, and thus wonderfully improve the sanitary condition of the city.

As an adjunct of this system of underground sewerage, and as a valuable auxiliary to the general plan of sanitary improvement, it can easily be arranged for the water of the Mississippi river during at least three months of the year, when it is in the neighborhood of flood height, to be conveyed by iron pipes through the levee on the river front into every street, and thus keep the gutters and sewers thoroughly washed and cleansed at a season of the year when it is most needed. The iron pipes for this purpose can be constructed with an adjustable gate, so that when the water is not needed during a rainy period it can be cut off, and when the gate is opened the water will flow of its own accord, as long as it is within four or five feet of highwater mark. The period of the year when the water would thus flow from the river would be generally from the 1st of April to the 1st of July.

The value and importance then of this improvement, as a means of sanitary reform, can scarcely be overestimated, and it seems as if nature had placed within our reach one great compensating advantage for the many other disadvantages with which she has surrounded us.

In view of the advanced stage of the work now being prosecuted by the dredge boats of the Mississippi and Mexican Gulf Ship Canal Company, it is idle to discuss for the present the feasibility or better adaptation of any other plan for the drainage redemption of New Orleans There has already been expended the sum of about two millions of dollars upon the work, and it is now about one half completed. All of the suggestions, therefore, which have been made in this paper have been based upon the presumed successful completion of this work. One great practical advantage which has already been achieved by it exists in the upper line protective levee, as shown upon the diagram, and which is finished in a substantial manner from the river to the lake. It happened that in 1849 the level broke at a point about fifteen miles above the city, and caused what is historically known in Louisiana as the Sauve Crevasse. The water from the break swept like a deluge upon the city, and for several months navigation in skiffs and canoes through the principal thoroughfares was the order of the day, causing a vast amount of inconvenience and damage,

The situation to-day is, that if a similar crevasse should occur, or a serious break in the levee take place at any point above the limits of the city, this upper line protection levee would act as such a barrier that no calamity like that of 1849 could ever with reasonable expectations happen again.

This levee, together with the lake shore revetment levee and the lower line protection levee, are being constructed from fifty to sixty feet wide on top, and from four to six feet above the highest water known, and are so arranged in their top cross sections that a shell road and a double car track will be afforded entirely around the city from K to L, a distance of about seventeen miles—thus promising a degree of utility with pleasure seldom combined e sewhere in a work of such vast public importance.

The future of New Orleans, as a great and populous city, depends more upon the successful solution of this drainage problem than almost any other question connected with her welfare. Give us the energy, the public spirit and the means to carry out this promised protection from overflow, combined with an efficient system of interior drainage, as herein marked out and with healthfulness thereby established, together with returning commercial prosperity, we will be enabled at no distant day to have our city extended through the present swamps to the shores of the lake, with beautiful homes occupying every foot of space within her limits, and capable too of maintaining a population of more than a million of people.

CO-ORDINATE SURVEYING.*

BY HENRY F. WALLING, C. E.

Concluded from page 112.

In this first case, the old co-ordinates of the new origin are, accordingly, positive while the new co-ordinates of the old origin are negative. Or, if we call the old co-ordinates a and b, and the new ones a' and b', a and b are here positive and a' and b' negative.

2d. When the new origin is west and north of the old, or a negative, b positive, a' positive and b' negative.

3d. When the new origin is west and south of the old, or a and b negative, and a' and b' positive.

4th. When the new origin is east and south of the old, or a positive, b negative, a' negative and b' positive.

For ascertaining the new co-ordinates of the old origin, the equations—

$$-a' = a \cos.\ \varphi + b \sin.\ \varphi,$$
$$-b' = b \cos.\ \varphi - a \sin.\ \varphi,$$

would prove correct in all these cases, provided proper positive and negative values were given to the different terms in the equations. It is necessary to remember, however, that φ, the angle of change in direction, between the old and new axes, is positive according to trigonometrical usage when reckoned from zero around towards the left, and negative in the opposite direction, while according to the geodetic method of estimating azimuths, positive angles are reckoned around to the right.

To avoid the confusion which might arise from these different methods of estimating angles, or from assigning a negative value to φ, equations are given below for each of the four cases. Their correctness will be apparent on simple inspection of the accompanying figures, in which O and N are the old and new origins respectively:

CASE FIRST.

$$a' = a \cos.\ \varphi \quad b \sin.\ \varphi,$$
$$b' = b \cos.\ \varphi - a \sin.\ \varphi.$$

CASE SECOND.

$$a' = a \cos.\ \varphi + b \sin.\ \varphi,$$
$$b' = b \cos.\ \varphi - a \sin.\ \varphi.$$

CASE THIRD.

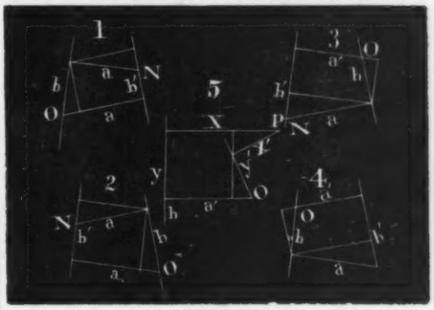
$$a' = a \cos.\ \varphi - b \sin.\ \varphi,$$
$$b' = b \cos.\ \varphi + a \sin.\ \varphi.$$

CASE FOURTH.

$$a' = a \cos.\ \varphi - b \sin.\ \varphi,$$
$$a' = b' \cos.\ \varphi + a \sin.\ \varphi.$$

In these equations the negative sign is omitted before a' and b', but we must remember that they are always estimated in directions opposite to those of a and b.

Since φ is a very small angle, *cos.* φ approximates closely to unity, and it appears by these equations that



a' is greater than a, and b' is less than b when the new origin is farther *north* than the old, while a' is less than a, and b' greater than b when the new origin is farther *south* than the old.

Having found the new ordinates of the old origin, that is of O referred to N, the ordinates of any point referred to the new origin may be computed from its old ordinates by the equations:

$$x = x' \cos.\ \varphi - y' \sin.\ \varphi + a$$
$$y = x' \sin.\ \varphi + y' \cos.\ \varphi + b;$$

in which x = departure of any point as referred to N,
x' = departure of the same point as referred to O,
y = difference in latitude of any point as red to N,
y' = difference in latitude of the same point as referred to O,
a = departure of the origin of O as referred to N,
b = difference in latitude of the origin of O as referred to N,
φ = the angle of convergence of the meridional axes of N and O.

These are the formulæ for passing from one system of rectangular co-ordinates to another in the same plane.

In these equations, we may consider north and east to be the positive directions as before, the opposite directions being negative. Also *sin.* φ is positive when the change of axial direction is towards the left, and negative when in the opposite direction; that is, positive when N is farther east than O, and negative when farther west. *Cos.* φ will always be positive, since φ is always either in the first or fourth quadrants.

In Fig. 5, the point P, of which x and y are the new co-ordinates, is east and north of the axes passing through O, making x and y greater than a and b respectively, and all the terms of both equations have, accordingly, positive values. But if x, x' or a be estimated towards the west, its sign must be reversed when particular values are substituted in the equations; likewise, if y, y' or b, have a southern direction, its sign must be reversed;

CO-ORDINATES IN A SINGLE DISTRICT.

It is hardly necessary to say that when the azimuth and distance are given from a point whose co-ordinates are known to any other point, the co-ordinates of the latter are found by multiplying the given distance by the sine and co-sine of the azimuth, the first product giving the departure and the other the difference of latitude.

VERIFICATIONS.

Before finally establishing the co-ordinates of a survey its accuracy should be tested in the most rigid manner, both as regards the instrumental observations and

the computations. The computations are easily verified by working to the same point from different directions.

COMPUTATION OF AREAS.

Areas are computed under this system with special facility and certainty, the method being the common one of double latitudes and departures. This method is prescribed by law in the State of Ohio, for calculating areas of farming lands and for testing the accuracy of surveys made with the surveyor's compass.

DESCRIPTIONS FOR CONVEYANCES.

For definite and accurate descriptions of land in conveyances, it does not seem possible to devise a more precise and certain method than that of co-ordinates from geodetically determined reference points or origins. The present loose and indefinite descriptions in conveyances, upon which the tenure of a large part of the real estate of the country now depends, are disgracefully uncertain and frequently lead to excessive expenses of unnecessary litigation, and sometimes to costly errors of misplaced constructions.

CONVENIENCE IN CONSTRUCTING MAPS.

In the construction of maps and plans, co-ordinate determinations will be found especially convenient. After completing the survey of any portion of a district it is easy to place it in its proper position upon the map of the entire district with the certainty that other portions subsequently surveyed will fit into their proper places without the perplexity and the distortions frequently accompanying the attempts to unite two or more independent surveys made under the methods in common use.

SUMMARY OF ADVANTAGES.

A few of the advantages which may be expected to follow the general adoption of the co-ordinate method of surveying may be summed up as follows.

First—The attainment of the highest practicable degree of accuracy, as well in smaller local surveys as in more extended operations. The units of measurement which form the basis of the United States Coast Survey have been most carefully compared with those of the entire civilized world, and with the dimensions of the earth itself, and are verified to a degree of precision beyond which the present attainments of scientific skill have not passed.

Second.—Extreme simplicity of notation with ease and convenience of field work and computation.

Third.—Facility in graphic representation.

Fourth.—Absolute certainty of locations in descriptions for conveyances, and consequent removal of a fruitful cause of litigation and trouble.

ALTITUDES.

No change is proposed in the existing methods of determining the third ordinate or altitude. The most convenient mode of fixing this ordinate, pre-supposes that the form of the earth's surface, or of that surface which would be presented if the irregular surface of the land were razed to the level of the sea, has been accurately determined by geodetic operations, so that in ordinary surveying we have only to ascertain the heights of our points of survey above this imaginary level. This is done by using the spirit level, by measuring vertical angles and by barometrical observations. The first method admits the greatest degree of precision under ordinary circumstances, and is almost exclusively used for engineering purposes.

THE PUBLIC WORKS OF INDIA.*

(*Concluded from page 111.*)

Justice has been done to the work undertaken by the Civil Engineer in India by the Government Director of the Indian Railway companies. The Engineer had to contend against the forces of nature to a far greater extent than is the case in England. He had to overcome the difficulties which the gigantic features of the country placed in his way; he had often poor materials and inferior labor at his command; and he had to meet the dangers of exposure to a burning sun by day, and malarious vapors by night. To the aid of his skill and professional knowledge he accordingly had to bring more than ordinary courage and endurance. Many have broken down in the attempt, but their places have been immediately filled by others, and the result is exhibited in the thousands of miles of railway which thread their way over mountain passes, cut through thick jungles, and span huge and uncertain rivers.

From Bombay runs the line of the great Indian Peninsula Railway, proceeding in a north-easterly direction for thirty-three miles to Kalian, where it divides into two branches. Of these, one runs for 583 miles also in a north-easterly direction, to Jabulpur, the point of junction with the East Indian Railway, with a branch at the 276th mile to Nagpur, which is 520 miles from Bombay. The other takes a south-easterly course to Raichur, where, at the distance of 462 miles from Bombay, it has a junction with the Madras Railway. The total length of line is 1,287 miles.

The Jabulpur line of the East Indian Railway proceeds from its junction with the northeastern fork of the Great Indian Peninsular line to Allahabad, a distance of 229 miles, making a total distance of 845 miles from Bombay. Allahabad is on the main line of the East Indian Railway, which runs approximately parallel to the course of the Ganges valley in a south-easterly direction, curving from Delhi to Calcutta, or rather to Howrah, on the right bank of the Ganges, opposite to Calcutta. From Delhi to Allahabad is 390 miles, and it is 564 miles from Allahabad to Howrah. Besides the Jabulpur branch before mentioned, the East Indian Railway has a loop-line of 315 miles in length, between Kanu, 75 miles from Calcutta, and Lakhmisarai, which is at the 262d mile of the main line. From Delhi the line of communication is prolonged by the Sind, Punjab, & Delhi Railway, which runs first in a northerly and northwesterly direction to Lahore, a distance of 348 miles, and thence in a north-westerly course to Mooltan, 556 miles from Delhi. Of the projected prolongation of the Sind section of this line down the valley of the Indus to the port of Karachi, 109 miles from that place up the valley to Kotri are completed. The Oudh & Rohilcund Railway has a course of 414 miles of the main line running nearly parallel to that of the East Indian Railway, and 128 miles of branches. The Bombay, Baroda, and Central India Railway skirts the coast of the Arabian Sea and the Gulf of Cambay, and runs behind the isthmus separating that estuary from the Gulf of Cutch, to Wadhwan, a distance of 389 miles, with a branch of 31 miles to Dakoor and Pali. The Madras Railway runs from Raichur, the terminus of the southeastern fork of the Great Indian Peninsular Railway, in a prolongation of this line to Madras, which is distant 350 miles from Raichur, and 793 miles from Bombay. From Arconam, a point on this line 42 miles northwest of Madras, the southwest line of the Madras Railway runs for 201 miles to Erod, and then turning to the west to Beypur, on the western coast, 406 miles miles from Madras. Including four branches, the length of the Madras Railway will be 858 miles. From Erod the South Indian Railway runs for 168 miles to Nagapatam, on the Eastern coast, while by a second line running south it reaches Tuticorin. This main system of Indian railways, executed under the guarantee of the Government, is completed by the 156 miles of the Eastern Bengal Railway from Calcutta to Goalandu. The length, when complete, with the exception of the missing link from Kotri to Mooltan, will amount to 6,041 miles. Including the State lines, which are generally projected on a narrow gauge, the sanction of the Government has been given to the construction of 9,415 miles of railway. The total amount expended on Indian railways to 31st March, 1876, was £105,790,929 of which £93,720,794 consisted of guaranteed capital, and £12,070,135 of funds raised directly by the Government.

The whole extent of railway now completed in India is 6,497 miles, of which 261 miles were opened in 1875. Of the total length, 768 miles are constructed with a double, and 5,729 with a single line; 5,676 miles are on the 5 ft. 6 in. gauge, 27 on a gauge of 4 ft., and 794 on lines of a metre, or 3 ft. 3⅜ in. The division of gauge pretty nearly corresponds to the distinction between the guaranteed lines, 5,710 miles in length (which have been constructed by public companies, under a guarantee of 5 per cent. interest on the capital expended, given by the Government, and which have been laid on the 66 inch gauge), and the subsidiary lines which have been made by the State directly, on a smaller gauge. By dividing the capital of £93,720,794, defrayed from guaranteed share capital, debentures, or debenture stock issued by the companies, by the tabulated length of 5,710 miles open on these eight great lines, we arrive at the average cost of about £16,400 per mile over the entire net-work; while the cost of the 1,504 miles of the East Indian line alone is close upon £20,000 per mile which reduces that of the remaining guaranteed lines to an average of about £15,000 per mile. On the State lines the Government had expended, to 31st December, 1875, the sum of £12,070,135. Taking the lengths tabulated which amount to 751 miles, the cost of these lines, which are ten in number, appears to exceed that of the majority of the guaranteed lines, being almost exactly £16,000 per mile.

It only remains, in order to give a comprehensive view of the Indian railway system, to add that the total length of line sanctioned up to the present time is 9,416 miles. Of the 2,978 miles which remain to be finished, 502 miles are on the guaranteed lines of the South Indian and the Oudh and Rohilcund Railways, and the remainder are distributed over the State lines, seven of which are as yet without any part open. The total number of State lines, when this project is carried out, will be nineteen, and their aggregate length will be 3,216 miles. This includes the 508 miles of that very important link, the Indus Valley line, which, though made by the State, is properly designed on the usual Indian gauge of 66 inches.

In approaching the question of subsidiary communications, the question no longer lies between locomotive and horse propulsion; it rather arises between the respective advantages of land and water communication. That the utmost possible extent should be given to both modes of opening up the country there is no room to doubt. But two considerations are enough to show that the organization of water carriage ought to occupy the attention of a statesman. The first of these is that roads can be, and are, everywhere executed in detail, and aided by local exactions, and that such exactions may be multiplied to any extent without one road interfering with another. Combination is possible, but there is little room for any injurious competition. With water transport, on the other hand, the case is entirely different. The canals, or the artificial navigation of a great country, can only be properly executed as component parts of a well considered system. Another feature of canal communication, which in India assumes the utmost importance, is that the use of a canal as a highway is not the only, nor even in most cases the most important, service rendered to a district by its canals. They are, as we before said, the conduits of irrigation. It is true that the same quantity of water cannot be used at the same time to convey water borne traffic and to flood paddy-fields. But even the same bulk of water may be thus successfully employed. It may flow gently for hundreds of miles, bearing the traffic of the district on its surface, and then, instead of being allowed to waste its fertilizing store in the sea, it may be applied to the needs of the agriculturist. It follows that those who are so loudly calling for the canalization of different water-courses of India, are to a certain extent fully in the right. They but little, if at all, exaggerate the services which may thus be rendered to the agriculture of the country. How far they are correct as to the facilities that may be afforded for transport is rather a question of detail, dependent, to a great extent, on facts as to area, watershed, rainfall and other physical facts, which can neither be neglected nor taken for granted.

The importance of irrigation in India is not to be measured by money alone. To a certain extent, of course, a money valuation is not only possible, but must be the basis of every well-considered system of canal or of other hydraulic work. But we are little accustomed to realize in this country, the extent to which the inhabitant of India is dependent on the general rainfall. The meteorological phenomena of India are on a scale, and are ordinarily attended by a regularity, of which we can form no practical conception. Our stormy skies send us rain perhaps on 160 out of the 365 days of the year; but a difference of 30 days, either more or less, is one that hardly attracts any serious attention. But in India, when the monsoon rains fail, as they have recently again done, the result is famine. Famine at least can only be prevented by irrigation. In those districts where, as before mentioned irrigation is necessary, and where it may practically be ensured by hydraulic works, the execution of such works may be

* From the British Quarterly for April.

the means, in any case of drought, of saving lives, not by thousands, but by hundreds of thousands.

The ancient and simple method which has, time immemorial, been employed in India for raising water from wells for the purpose of irrigation, is the *picottah*. The work of a laborer engaged in this hydraulic operation bears a very strong resemblance to the game practised by English boys under the name of see-saw. A post, a portion of a tree, is driven into the ground adjacent to the well or other source of supply. Very often this takes root and throws out branches which afford a grateful shadow to the laborer. This post is forked at the top, and bears a long plank, which is notched near the middle, to prevent its slipping from the support, on which it can freely vibrate like the beam of a balance. A bamboo is attached to the end of the plank over the well, and a water-vessel is fixed to the bamboo. This forms the entire apparatus. The task of the laborer consists in walking backwards and forwards along the plank. When he approaches the loaded end the vessel dips into the water; when he returns to the other end, the vessel, full of water, is raised into the air to the height proper for discharge. The day's work finished, the native carries home his water-vessel, and also the bamboo, if the latter be of sufficient value to steal. The cost of raising water by this simple method is about the same as that by the more costly apparatus of a bullock wheel, that is to say, about £1 sterling for every 3,000 cubic yards of water.

This cost, low as it is when compared to the productive value of the water thus raised when applied to the land, is very high in proportion to the price at which water can be produced by well conducted public works. Sir Arthur Cotton, in a series of lectures on Irrigation Works in India, delivered at the School of Military Engineering at Chatham, in November, 1874, gives the following prices: For water raised fifteen feet by animal power, as in the case of the *picottah* or bullock wheel, 3,000 cubic yards per £1. For water raised twenty feet by steam power, 20,000 cubic yards per £1. For water stored in tanks constructed for the purpose, from 40,000 to 60,000 cubic yards per £1. For water drawn from rivers and distributed by irrigation canals, from 20,000 to 70,000 cubic yards per £1. If we take as a moderate average, for the sake of keeping to round numbers, the rate of 24,000 cubic yards per pound sterling, each entire yard of water will cost one-hundredth part of a penny. The average price of the water supply of London is 1*s.* 4*d.* per cubic yard, or 140 times as much.

In the impossibility which exists of giving within a limited space any estimation or exhaustive account of the main irrigation works completed, or in course of execution in India, it may be desirable to reproduce the principal features of the account given by Sir Arthur Cotton of the works on the Godaveri, which are among the most important in India. This river, as we have before remarked, has a course of 898 miles, and drains an area of 112,200 square miles. Its delta contains a million of acres. At the apex, or head, of this delta, the river is four miles wide, including two islands, which are covered with from three to ten feet of water in the freshes. When the river is full these islands divide its course into four channels, having an aggregate width of some 4,000 yards. At the close of the dry season the water is not more than one foot deep at the fords but in extreme floods it rises as much as thirty-one feet. The volume discharged in the former case is estimated at about 300,000 cubic yards per hour, which is less than a fifth part of the volume of the Nile at Cairo, when at its lowest in the month of June. But the discharge of the Godaveri in a thirty-one feet flood is given by Sir Arthur Cotton at 180,000,000 cubic yards per hour, while the October flow of the Nile, at its average flood for that, its highest month, has been accurately measured by Mr. Fowler at a little under 26,000,000 cubic yards per hour. The average height of the rise of the Nile, corresponding to this delivery, is 22½ feet. The floods of the Godaveri are comparatively brief in their duration, but the above comparison affords some measure of the enormous volume of water that at certain seasons comes down the river, a volume which of course complicates the work of the engineer to an extent of which those unacquainted with the localities can form but little conception.

The fall of the Godaveri from the head of the delta is at the rate of 1¼ feet per mile. The level of the adjoining land is twenty-eight feet above low water line, or about three feet under flood line. The land slopes rapidly from the edge of the river, so that the natural surface may be reached by a canal within 5 or 6 miles, if a water level be maintained intermediate between the old low water line and the flood line. This has been effected by the construction across the Godaveri of a weir, or, as it is called in Hindostan, an *annicut*, of masonry. This noble work is two and a half miles long and forty-eight feet wide, of which eighteen feet are level, and the remaining thirty feet form a curved slope. The level sill or platform of the *annicut* is fifteen and a half feet above the old low water level, and provision is made for raising this height an additional two and a half feet, in the dry season, by planks. The material of this immense river wall is hard sand stone, the surface over which the water flows being covered with well fitted and dressed blocks of two feet in thickness. Below the thirty feet of slope is a loose stone apron of twenty-five yards broad, composed of large blocks carefully packed, with a very slight slope.

From the middle and from the end of the *annicut* are led three canals, each of them sixty yards wide, and carrying eight feet of waterwhen full. The water is admitted to each by a head sluice, and this is accompanied by a lock a hundred and fifty feet long and fifteen wide, in order to accommodate the navigation of the canals and river. The fall of each canal is equal to the ordinary allowance, in the English fen districts, of four inches per mile, giving a current of two thousand five hundreu yards per hour, and thus conveying in all one million cubic yards of water per hour. Adjoining each head sluice, at a level four feet below that of the bottom of the canal, is constructed an under sluice. Each of these is capable of discharging a million cubic yards of water per hour. The object of these is, by opening at proper seasons, to scour out the bed of the river near the heads of the canals, and thus prevent the silting up of the latter, a precaution rendered necessary by the immense mass of *debris* annually brought down by the flood of the Godaveri. Iron posts, furnished with grooves, are built into the crest of the *annicut* in order to receive the planks above referred to as added in the dry season. These standards are eight feet apart and two feet six inches high. The planks are removed before the monsoon. It has occurred that freshes have come down the river while the planks were in place. No danger has hitherto occurred from this, but care is now taken to prevent it, as tidings of the rise of the river are obtained many days before the flood reaches the *annicut*.

This important work contains 800,000 tons of stone, besides many millions of bricks. It was constructed of sandstone quarried from a hill on the spot, and subsequently covered with two feet of harder stone, brought to the works from a distance by the navigation, when rendered available. An admirable hydraulic lime was burned from a limestone quarried within a few miles of the *annicut*.

The work has now stood for twenty-eight years, having only once been breached by a flood. This damage happily occurred at a time of year when no very considerable damage was caused to the crops, and the cost of repairs was not over the modest sum of £6,000. The water is carried in the canals at a level two or three feet above that of the adjacent land, to which it is admitted by sluices in the canal banks. Drains are cut between every two irrigating canals, to carry off the local rainfall, which is exceedingly heavy. Some of these drains are as much as 20 or 30 yards broad. As yet the system has been applied to the surface of only 600,000 acres out of 1,000,000 acres of the delta. It has already cost £600,000, and Sir Arthur estimates that the ultimate cost of the completed works, applied to the whole delta, will be about a million sterling, that is to say, a pound per acre.

The works in existence, in course of execution, or in a state of prospect, with reference to irrigation in India, are primarily divided according to the position of the great river basins in which they lie. They are tabulated as those of the Indus basin, the Ganges basin, the Mahanadi basin, the Narbada and Tafti basins, the Madras system of irrigation, and the embankments against floods in Bengal and British Burmah. We have before remarked that many of the canals are adapted both for irrigation and navigation.

As soon as the Sirhind Canal works are completed, there will be navigable communication from Calcutta up the Ganges, by the canal to the Sutlej, and down the Indus to Karachi. The delta canals of Madras are much used for boat traffic, as well as the high level and Cochrane's Canal.

It is impossible to condense in a simple paper, any adequate account of what has been done, what is now in course of execution, and what remains to do, in order to endow British India with an adequate system of primary lines of communication by land and by water, comprising under the latter head the services of irrigation as well as those of navigation. To tell, with some degree of precision and of detail, the story of one great work, is to indicate what we may repeat again and again over no inconsiderable portion of the 943,400 square miles which form the area of British India.

CORRESPONDENCE.

DALLAS, TEXAS, *May 1 t, 1877.*

EDITOR ENGINEERING NEWS:

SIR—I would like to know if you or any of your readers and correspondents have any experience with brick street-gutters. We have no suitable stone, are tired of plank, and seek a substitute not too expensive. Can you send me a cross section of a brick-gutter, and specifications for laying them down. Our grades are only 6 in. in 100 ft., and water is quite slow in the gutter.

Yours truly,

WM. JOHNSON, *City Eng.*

FOUNTAIN CITY, *April 23d, 1877*

EDITOR ENGINEERING NEWS:

SIR—I was lately called upon to establish the ¼ section corner with line between Section 2 and 3, T. 21, N. R. 11 W.: The corner was completely lost, and it was necessary to run out the whole line to establish the same. I found it by actual measurement, 83.03 chains instead of 85.61, government distance given; I established the ¼ corner at 44.23 chains from the north and at 38.80 chains from the south section corners. Section 2 was formerly sub-divided by a surveyor who seems to have divided it according to the number of acres, or giving full measure for fraction, and his corner consequently was several rods further south. Yours truly,

J. B.

ANS.—You have divided the line correctly to obtain the quarter corner. Areas do not enter into the location of corners; they serve as a check and are useful as pointing out the intention of the government.—[ED.

GALESBURG, ILL., *May 3, 1877.*

EDITOR ENGINEERING NEWS.

SIR.—I send you the following statement of facts in regard to a survey, and desire your opinion or the opinion of some of your subscribers who understand such matters.

On the line between sections 24 and 25 the middle corner is lost; there are no traces left of the witness trees. Field notes describe the corner as 40 chains 70 links from the west corner, and 39 chains 30 links from the east corner. The corner has been twice re-established by County Surveyors. One insisted on following the field notes, found the centre of the line and placed the stake 70 links east. The other insisted on placing the stake at the centre of the line, that the duty of the government surveyor was to divide the section equally, and that the memoranda on the field notes cannot be right.

Please reply and oblige one who has read ENGINEERING NEWS from its beginning and is much interested in it.

Yours,

G. C.

ANS.—In the absence of reliable evidence as to the original location of the corner in question the *only* way to proceed is according to the following proportion:—As 80 chains is to the actual length, by your chaining of the north line of the section, so is 39.30 chains to the distance from the east corner to the correct point of location of the quarter corner; in short, divide the line *pro rata*.—[ED.

IT is often the case that sewers become choked up because they are too large, there not being sufficient depth in the constant flow of water to carry off the ordinary obstructions, there, is a gradual deposit which in times fill the sewer.

These difficulties are obviated in the use of the *Salt Glazed Vitrified Sewer Pipe*. This pipe is made from a clay that, by the chemical action of salt, used while burning, becomes covered by a glazing that will not wear off, and is impervious to the action of acids, gases, steam, or any other known substances, and the pipe itself becomes vitrified. The surface being smooth as glass affords no lodgment for any of the substances passing through the sewer.

A series of tests made in Boston, Washington, and Chicago, which consisted in the "crushing test," "breaking test," and the "abrasion test," to which the different kinds of American and Scotch pipes were subjected, resulted in the favor of the *Akron Standard Salt Glazed Sewer Pipe* in each and every particular. This pipe is manufactured at Akron, O., the interest being one of considerable extent, the Akron Sewer Pipe Association, which combines three of the most extensive sewer pipe manufactories in America, viz: the "Akron Sewer Pipe Company," "Buckeye Sewer Pipe Company," and "Camp, Cook & Co.," having a combined capacity of from 1,200 to 1,500 car loads yearly.

The clay used is obtained from the banks adjoining the works, and is known as the 'Akron," or "Summit Clays," which analysis proves to be unequalled. By skilled labor and powerful machinery of the latest and best designs the material is rendered uniform. Under great pressure the pipe is made very compact, and at a high temperature becomes a thoroughly vitrified and iron-like body, imperishable and indestructible by any of the elements to which they may be subjected. The pipe is made in sizes from two inches to two feet in diameter, and of all forms, from the straight to the curved, embracing "Traps," "Elbows," "Slants," "Branches," etc.

The principle market for the past two years, has been in the New England States, where the Scotch pipe has heretofore monopolized the trade, although immense quantities of goods are shipped West and North.—*Merchant's and Manufacturer's Review.*

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 116.*)

59. A shear at a joint, if desired, can be found by taking the mean of the two adjacent shears just obtained. A table which accompanies this section has been computed for the middle points of twenty divisions; it is intended to supplement the previous table of bending moments, and will serve as a guide for the calculation of any table with a greater or less number of spaces. Besides, it is easy to select from this table that combination of loads which will give on any parabolic arch, hinged at the ends only,

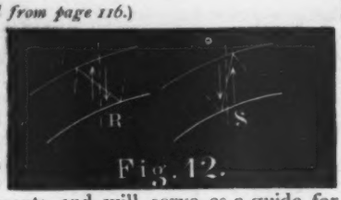


Fig. 12.

PARABOLIC ARCH, HINGED AT END. TABLE FOR F. $F = r W$. VALUES OF r.

Point of Division.	W on 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		+.832	−.155	−.143	−.131	−.118	−.106	−.093	−.081	−.069	−.056	−.044	−.031	−.019	−.007	+.006	+.018	+.031	+.043	+.055
2		+.666	+.691	−.284	−.270	−.235	−.211	−.186	−.161	−.137	−.112	−.088	−.063	−.038	−.014	+.011	+.035	+.060	+.084	+.109
3		+.508	+.544	+.550	−.384	−.318	−.312	−.276	−.240	−.204	−.168	−.132	−.096	−.060	−.024	+.012	+.048	+.084	+.120	+.156
4		+.359	+.406	+.455	+.495	−.455	−.444	−.362	−.316	−.270	−.223	−.177	−.130	−.084	−.038	+.009	+.055	+.102	+.148	+.194
5		+.222	+.277	+.333	+.390	+.444	−.500	−.445	−.390	−.333	−.276	−.220	−.163	−.107	−.050	+.006	+.063	+.120	+.176	+.233
6		+.097	+.159	+.223	+.287	+.350	+.414	−.469	−.414	−.358	−.303	−.247	−.191	−.135	−.079	−.022	+.034	+.091	+.147	+.204
7		+.013	+.057	+.126	+.190	+.266	+.330	+.406	−.454	−.395	−.337	−.281	−.225	−.169	−.113	−.057	−.000	+.056	+.112	+.169
8		−.107	+.032	+.042	+.116	+.191	+.265	+.340	+.414	−.454	−.395	−.337	−.281	−.225	−.169	−.113	−.057	−.000	+.056	+.112
9		−.183	−.106	−.029	+.048	+.125	+.203	+.280	+.357	+.434	−.479	−.422	−.365	−.309	−.252	−.196	−.139	−.083	−.026	+.030
10		−.243	−.165	−.086	+.008	+.070	+.143	+.226	+.304	+.383	+.461	−.461	−.404	−.348	−.291	−.235	−.178	−.122	−.065	−.009
11		−.273	−.206	−.158	−.084	+.025	+.103	+.187	+.271	+.354	+.438	+.480	−.437	−.381	−.324	−.268	−.211	−.155	−.098	−.042
12		−.307	−.232	−.173	−.104	+.034	+.096	+.160	+.214	+.268	+.322	+.376	+.430	−.434	−.377	−.321	−.264	−.208	−.151	−.095
13		−.313	−.241	−.177	−.113	+.050	+.014	+.077	+.141	+.205	+.268	+.332	+.385	+.439	−.414	−.357	−.301	−.244	−.188	−.131
14		−.294	−.241	−.187	−.133	+.080	0	+.055	+.111	+.167	+.223	+.278	+.332	+.385	+.439	−.406	−.349	−.293	−.236	−.180
15		−.278	−.223	−.167	−.111	+.056	+.009	+.038	+.084	+.130	+.177	+.223	+.268	+.315	+.362	+.406	−.444	−.387	−.331	−.274
16		−.241	−.194	−.148	−.102	+.055	+.012	+.024	+.060	+.096	+.132	+.168	+.205	+.245	+.285	+.326	+.367	−.409	−.352	−.296
17		−.192	−.156	−.120	−.084	+.018	−.011	+.014	+.035	+.063	+.088	+.112	+.137	+.175	+.214	+.257	+.303	+.348	−.391	−.335
18		−.136	−.102	−.084	−.060	−.035	−.011	−.007	+.019	+.031	+.044	+.056	+.069	+.081	+.093	+.106	+.118	+.131	+.143	−.154
19		−.063	−.055	−.043	−.031	−.018	−.006	−.000	−.007	−.019	−.031	−.044	−.056	−.069	−.081	−.093	−.106	−.118	−.131	−.143

the maximum shear of either kind in any one division, one arrangement being the complement of the other. These shears, as should be the case, foot up very nearly to zero for an equal load on every joint. It is only necessary to calculate one half of the table, the other half containing the same numbers in the reverse order, and with the opposite signs.

It may be seen, from a comparison of this table with the one for M, that, as in a beam, the points of maximum flexure occur where the shear changes sign.

60. In the case of single span trusses, the maxima bending moments, and consequently the maxima stresses in the chords, occur when the bridge is entirely covered with the live load, and the greatest shear at any section, or the greatest stress in any brace exists when the bridge is covered with live load over one or the other, usually the longer, of the two segments into which the section divides the span. A simple inspection of the tables for M and F, lately given, will show that such rules are not true for an arch. Why this is so will be seen, if we consider the fact that the portion of arch, in Fig. 10, between B and the point where C A crosses the rib is under a bending moment of the positive kind, while from that point to A bending moments of the negative kind exist, and that an addition of another load near I, will increase most of the positive and negative moments in amount, while one placed on the left half of the arch will have an opposite effect. The shearing forces for the braces, depending on the stresses on the flanges, will be also affected in the same way.

61. An attempt has been made to represent, by the horizontal lines in the accompanying diagram, Fig. 13, those positions of the live load, or the extent of the loaded portion, which will give the maxima moments of both kinds at each of the nineteen points, and also that arrangement of the live load which gives the maximum shear of either kind at the middle of each division. The full line denotes the loaded portion of the span when the maximum positive moment occurs at that point whose number is placed at the end of the line, positive being understood to mean that kind of moment which would make a previously straight beam concave on the upper side; and the remaining portion of the span must alone be covered with the live load to produce the maximum negative moment at the same point. Thus the maximum positive bending moment at 2, and at 3 also, is found when the load is on allpoints from the left to 7 inclusive. A load from 8 to the right abutment gives the maximum—M. The maximum + M at 11 occurs when the arch is loaded from 9 to 14 inclusive. The extent of live load required to produce the greatest upward, or positive shear on the left of a vertical section through the web or brace in any division is indicated by the broken line drawn in its proper space, and a load over the complementary blank portion will give the maximum shear of the opposite kind in the same division. Thus, the maximum + F, at the middle of 3-4, is found when the load extends from 4 to 9 inclusive, and the maximum—F, at the same place, when the load reaches from 1 to 3 and 10 to 19 inclusive.

62. As a partial load, not extending to either abutment, will give the greatest M at some points, and as the same thing is true of the values of F, those writers who determine the greatest stresses by the usual test for maximum applied to an algebraic equation, which contains the expression for load as continuous from one abutment, must err in their results. We have endeavored to explain the construction of these tables carefully, so that, if a different number of points of division, possibly not equidistant horizontally, are desired for a specific design, the reader can reproduce them for himself, either by new computations or by interpolation.

63. It must be remembered that the steady or fixed load, unless distributed uniformly horizontally, gives some definite bending moment and shear, of one sign or the other, at each point, and these amounts must first be obtained from the tables or by diagram. Then when the rolling load is introduced, it may only be able, at some places, to reduce the amount previously existing, without making it pass zero and change sign. For instance, if, at a given point, the bending moment from fixed weight is +, the arrangement of rolling load which gives the maximum + M at that point will conspire with the steady load and give an actual maximum + M; while that arrangement of rolling load which, in itself, gives a maximum − M will reduce the moment from steady load. If large enough to prevail against the + M, the rolling load will produce an actual maximum − M; but, if not, it will only cause a minimum + M. Similar remarks might be made concerning shear. Finally, in every case, the direct thrust must be combined with the stress from bending moment, to give the resultant stresses in the rib.

As to an absolute maximum M of either kind, for a uniform load, it will be found, if we sum up the quantities in the table, to occur at thr 5th and 15th points of division, or at the middle of the half span. The loads to produce these values are seen in Fig. 13. The absolute ± F is found at the abutments, while another value, nearly equal in amount, occurs at the crown. These absolute maxima are found by comparing footings of the several columns.

As every additional weight increases H and therefore increases the direct thrust on a cross-section in the same proportion, while added weights on some points will diminish the previously existing bending moments and also the tension and compression which is caused by them, it is quite possible that the maximum resultant compression and tension in any portion of the flanges will be found for some other arrangements of loads than those which give maxima bending moments only. As the stress from bending moment depends on the depth of the rib and not on the rise of the arch,

(*To be continued.*)

NOTE.—Figure 13—which should have been presented at section 52, is unavoidably omitted in this issue.

In section 56 of our last, immediately before the italic sentence on the fourth line from the end of the paragraph, the words "in one figure representing positive or upward shear" must be inserted.

THE NEW YORK POST-OFFICE ACCIDENT.

The cause of the fall of a portion of the roof of the New York Post-Office building has been investigated by a coroner's jury, and also by a commission appointed by Postmaster James, acting under orders from Washington. We referred to the accident in our last issue, and gave some few particulars of the case at that time. The findings of the jury and the commission we give below and they are sufficiently explicit to call for scarcely any additional words of our own. That we have such definate results from the investigation is due largely to the fact that both bodies contained men well qualified to decide upon the matter, as will be seen when we state that, upon the coroner's jury were Mr. Richard M. Hunt, architect of the *Tribune* building, Mr. Leopold Eidlitz, at present in charge of the works on the Albany Capitol and the New York City Courthouse, Mr. Henry Fernbach, who has designed a number of large insurance company buildings, Mr. Richard M. Upjohn, who has now under his charge the Connecticut State Capitol at Hartford, besides several practical builders. Postmaster James called to his aid Theodore Weston, architect of the Equitable Building, Wm. D. Jardine, architect of the Western Union Building, Walter W. Adams, Superintendent of Buildings, A. J. Campbell, of the Architectural Iron Works, and three builders. The United States Grand Jury have also investigated the cause of the disaster.

It appears that the truss was of some thirty-five feet span, to carry a portion of a fire-proof roof, in place of a 12 inch wall which was removed. This wall itself rested on I beams and had caused such deflection and cracking of the ceiling beneath it as to call for remedy. The truss rested at one end upon a cross-wall and at the other upon the plate and purlin of a Mansard roof. The weight of the roof was even greater than we stated last week, the concrete filling over the corrugated iron arches being five inches thick at the crown of the arches and fourteen inches thick at its deepest part over the nine-inch rolled beams which carried the arches.

By the testimony of Mr. Thos. H. Oakshott, who was Supervising Inspector of Material, and in charge of the construction of the new Post-Office, it also appears that he was a stone cutter by trade and had been inspector of masonry; that he furnished Henvelman, Haven & Co., of New York with a lithograph of the other similar trusses, and directed Mr. Haven to take his measurements from a truss in position under another portion of the roof; and that Mr. Haven's offer was for $233, or $205 less than the cost of the original trusses, which were built by the Kellogg Bridge Company.

Ex-supervising Architect Mullett was questioned as to his professional training, and said he had opened his career as a civil engineer in Cincinnati, where he had afterwards picked up the ability to draw designs. When asked what he meant by the parallelogram of forces, and also the resultant of two forces, he declined to answer general questions touching his professional knowledge as an engineer. The engineer, Gen. Wm. G. Steinmetz, who was also examined, satisfied the jury of his good capacity and experience, but unfortunately he, the only one who possessed sufficient technical knowledge, had only advisory functions, and was not consulted, and knew nothing about the truss.

There is apparent the grossest carelessness and ignorance in regard to the resistance of materials and their proper disposition, and the public will naturally and rightfully ask how do we know that other of our government buildings have not been botched in the same way, and may not contain dangerous points of construction. In regard to the I beams spoken of below, with a deflection of 5½ inches, the strain on the square inch at the worst places must be not less than from 30,000 lbs. to 40,000 lbs.

Mr. Hill, the Supervising architect of the Treasury Department lays the accident to the faulty construction of the building in the first place as the prime cause of the disaster, Mr. Mullett says that Mr. Hill procured the removal of Engineer and Asst. Supt. Steinmetz, who had previously been in charge of the work, and this he considers as the real cause of the accident.

The verdict of the coroner's jury was as follows:

We find the immediate cause of the falling of a portion of the roof of the New York Post-Office, on the 1st. day of May, 1877, to be from improper and insufficient construction; but that the primary cause of the disaster is attributable to the incompetency of the agents of the Treasury Department charged with the erection and completion of this building, and that the United States Government is responsible for this calamity.

We further find that an excessive quantity of concrete was used in the covering of the roof, and that the load thereby imposed upon the iron roof-beams and their support exceeds the weight for which the iron construction was originally designed by more than 300 per cent.; that all of this is owing to incompetency on the part of A. B. Mullett, Supervising Architect in charge at the time the roof was designed, and his local employees, and that the civil engineer—the only party appearing before us competent to design and compute methods of construction—has, according to the testimony no authority in carrying out the construction. His functions are entirely advisory; and that the Supervising Architect and his employees, not themselves technically intelligent, omitted to recur to his advice when changes were made by their authority. It appears that, on the removal of a wall on the fourth story, the remainder of the wall on the fifth story, left standing by order of A. B. Mullet, supported according to his direction, was supported by two light fifteen-inch iron beams, competent to carry only one-fourth of the weight imposed upon them; that this wall was recently taken out, to be replaced by an iron truss, and that the cost of the truss was reported to the Superintending Architect at Washington, D. C., by the local superintendent here, and the expenditure approved by him, but no special drawing was made for the new truss and its outer support; that the understanding between the local superintendent and the iron-workers was for a truss similar to another truss then in the building. It appears that neither the local superintendent nor said iron firm had the necessary technical information to correctly understand the functions of the truss needed, or how such a truss should be constructed, and that, in consequence, the truss and its support gave way as soon as the temporary props supporting the roof-beams were removed.

Furthermore, we are of the opinion that the method now in vogue in the Treasury Department, in Washington, of designing and constructing government buildings throughout the United States, demands intelligence in local superintendents in this or similar emergencies, which the government has certainly not in this case been successful in securing.

The conclusions of Postmaster James' commission are:

1. That the girder introduced under the wall when the alteration was made in the United States Court room was so insufficient for the purpose that it must have long ago failed had it not been for the fortunate fact that the brick wall which it supported was a particularly sound and strong one, and that it proved to be not only practically self-sustaining, but also (on the principle that it contained a natural arch) to have been able to hold the weight of the roof besides, and that the said girder is so insufficient in proportion that, when now relieved, as it was by the wall, from all the weight of the roof and all the weight of that portion of the wall itself above its natural line of fracture, which runs at an angle from the extreme ends of the girder, nothing but the fact that it happened to be constructed of exceptionally good iron and the floor above it had never been loaded by an ordinarily great weight, has prevented the Criminal Court room beneath from having been the possible scene of a far more serious accident than that which has now occurred in the room above it. The girder has now a deflection of 5½ inches, with a length of 35 feet 2½ inches between its bearings. The extent of the crack in the ceiling of the Criminal Court room did not necessarily indicate the exact curvature of and consequent danger from the girder, for the ceiling has some self-sustaining power independent of the floor on which it is hung, as is proved by the fact that many of its suspending-rods are loose (the floor has sagged in places more than the ceiling). As the strength of the girder is impaired, although the main load it was intended to carry is removed, and as under no condition is it strong enough to support with safety that portion of the floor alone, which it is still called upon to carry, your commission, under the circumstances, may be excused if they recommend that it be either materially strengthened or that its place be supported by a new and properly proportioned girder.

2. The wisdom of the order to remove the wall and supply its place with a truss is evident.

3. The roof truss adjacent to the truss that failed, which carries substantially the same load, is proved to be sufficient to support the roof with safety.

4. The letters of April 2 and 3, from Mr. Oakshott, Superintendent, to Mr Hill, Supervising Architect, and of Mr. Hill to Mr. Oakshott, prove that a contract was authorized for a truss which would have been adequate to safely support the roof.

5. The fact that important elements of stability and strength in the model truss are not found in the new truss explains its failure. The omission of a rafter with its bracing, which was a main reliance for the safe support of the end of the horizontal portion of the truss above it, was the primary cause of the accident. Its omission left the whole weight of one-half of 575¾ square feet of roof, with its iron beams, corrugated iron arches, and unnecessarily heavy concrete; also of the matal roofing and accidental load to be borne by a single strut 19¼ feet long, formed of the 10-inch channel bars, having 2¼ inch flanges, and their sectional area 3 2-10 inches placed back to back 3¼ inches apart, in the first 14 feet 8 inches of which, from the base, there are but two separations through each of which passes a ¾-inch bolt. The strut stood absolutely free and without lateral bracings. It was manifestly utterly incapable of sustaining the load placed upon it, and, as might of been expected, crippled (bent sideways) at a point three feet below its union with the truss. As no provision was made to brace the top chord of the truss laterally, either by bolting the deck beams of the roof to it directly or with angle irons, or by notching them on to it, it was deficient in lateral stiffness, and in danger of failure, of crippling the upper chord.

Finally, the present accident is due to two causes:

1. That the truss erected did not correspond with that recommended by Superintendent Oakshott, approved by Supervising Architect Hill, and apparently contracted for by Messrs. Henvelman, Haven & Co.

2. That the shores were removed and the truss was subjected to its load before it was examined by a person competent to determine if it was constructed in conformity with the contract.

Your commission considers that it is perhaps a fortunate circumstance that this accident, sad as it is, has led to the detection of the radical weakness of the hidden girder of the ceiling of the United States Court room, the continuance of which is now a source of jeopardy, and the community has great reasons to be thankful that they have been spared the details of a calamity far more appalling in its character.

THE FALL OF THE WINNEBAGO COUNTY COURT-HOUSE.

But a little more than ten days from the occurrence of the New York Post-Office disaster, we are called upon to notice the downfall of the Winnebago County Court-house at Rockford, Illinois, which took place Gay 11. This building was designed by Henry L. May, of Chicago, under an advertisement for plans in 1875, and Mr. W. D. Richardson, of Springfield, Illinois, obtained the contract for its erection, by a bid of $165,000. The structure was to be of brick, faced with Illinois stone, surmounted by a wooden roof and a massive stone dome. The corner-stone was laid June 22, 1876, and the work has since progressed at a reasonable rate. The roof was not yet entirely in place, but the stone cornice was being put on. Two pavilions on each side of the front entrance rise about thirty feet above the level of the cornice, and a dome between the two was 119 feet from the ground. It was supported by the front walls on the north side, and by two iron columns, from ten to twelve inches thick, on the inner side. These columns rested upon a brick wall, about thirty feet high, extending from the ground floor to the floor of the court room. Upon the top of the columns was a wrought-iron girder which supported the brickwork and stone veneer of the dome. As stated in a dispatch, it appears that the walls were entirely inadequate to hold the immense weight of the iron pillars and the mass of masonry of the dome which rested upon the pillars. The lower brick walls were crushed by the weight and crumbled, bringing with them the entire interior of the building, taking all the rafters and the corrugated iron ceiling of every room, with its concrete filling. Nine men have died from injuries received at present writing, and others are maimed for life. The outer walls remained standing, and some few of the men saved themselves by quickly taking refuge on them and in the window openings; among this number were W. D. Richardson, the contractor, and F. E. Latham, the Superintendent, who were on the upper part of the dome, and who are said to have been *talking of the probability of its falling*.

To whom blame should be imputed for this catastrophe it is impossible to say until we are put in possession of the expert testimony in the matter. The contractor has already ascribed the cause of the disaster to the architect, as he claims that the plans were strictly followed and the wall overloaded. It is stated that he has substituted stronger construction in some cases at his own expense, and that he has appealed for permission to strengthen supports, but was refused. If it is true that he entertained serious doubts of the building's strength, he ought to have refused to go on, and, so far, would be morally liable. It is worthy of note that he is said to have been discussing probabilities at the time of the accident. There seems to be a great faultiness in the construction of public buildings, and it is high time that decided action should be taken to prevent such calamitous occurrences. If the designer or constructor of a building, or any kind of a structure,

which, by falling through his fault, occasions the loss of life, should suffer the penalty for manslaughter, the effect of such severity would be wholesome. The Detroit *Free Press* remarks, "Designs for public buildings in which safety or solidity are sacrificed in the slightest degree to beauty or artistic proportion should be ruthlessly condemned; and if all these qualifications cannot be combined — and there is no reason to believe that that they cannot be with competent architects or builders — the former are infinitely to be preferred to the latter."

As to government buildings, the sources of trouble are well set forth in the reports in another column. In regard to other public buildings the difficulty is of another nature, depending upon the manner in which designs are obtained and contracts entered into. Unfortunately there are men, reputed to belong to our profession as well as to the allied profession of architects, who are really incompetent to plan and to carry out works which they aspire to design. Some way is needed of weeding out such hangers-on, and of making them powerless to waste money and jeopardize lives. A board of supervisors advertise for plans of a public building. It is seldom that they are competent to judge of the strength of the proposed construction and they rarely call expert judges to their aid: generally the design which gives the most ornate building at the least cost wins in the competition, practically introducing the requirement of sacrificing strength to looks, unless some private schemes have to be furthered at the same time. Then the contract is let to the lowest bidder, or, as it generally reads, to the lowest responsible bidder, although the case is rare where contractors' bonds have been enforced in case of failure. As a contractor's pecuniary interests are likely to be opposed to those of the other party, a superintendent must necessarily be employed to see that the specifications are carried out. If the superintendent is competent, well and good; but no enforcement of a contract for a poor and weak design will ever bring forth a good structure.

When we think of a bridge as opposed to a public building, there occurs to us one reason why a bridge that is somewhat deficient in stength may not show its weak points by failure, while the building excites suspicion; and this arises from the fact that the moving load forms so large a portion of the gross load in the former, and so little in the latter case. That some highway bridges still stand may be ascribed to the fact that they never have felt their greatest possible load.

To ensure a good design it is necessary that the submitted plans should be carefully examined and approved by men capable of judging, men selected for the task, and not office-holders by political nomination and election; that the contract should be let to a reputable builder at a reasonable and living price; and that the work in progress should be thoroughly supervised by one who has the ability and the power to modify minor details, if necessary. To put on a poor builder, and then to expect the superintendent to obtain good work from him, seems a strange requirement, but we have known those in authority who would do exactly that thing.

If we would single out the leading features which characterized the late Convention of Civil Engineers in New Orleans, it would be the princely generosity of the various railway companies which provided free transportation for so great a distance for so many people, the magnificent hospitality with which the members of the American Society and their guests were entertained by Capt. Eads, through his assistant, Mr. Corthell, and the sociability and good feeling that prevailed throughout the entire proceedings both in the meetings of the Society and in the excursions following.

The Eastern members received free transportation from New York city to Louisville by the direct routes thereto; at Louisville the following circular letter was furnished to all properly accredited members and guests:

Louisville & Great Southern Railroad Line.
Mobile & Montgomery Railroad,
New Orleans & Mobile Railroad,
New Orleans, St. Louis & Chicago Railroad Line.

LOUISVILLE, *April 20, 1877.*

Dear Sir: The courtesies of the lines between Louisville and New Orleans are hereby tendered to yourself and lady in passing to and from the ninth Annual Convention of the American Society of Civil Engineers, to be held in New Orleans, the 24th, 25th, and 26th days of the current month.

The presentation to conductors of this invitation, bearing the official stamp of Transportation Department, will secure you free transportation until May 15th, proximo.

E. D. STANDIFORD, *President.*
H. VICTOR NEWCOMB, *Vice Pres't.*
D. W. C. ROWLAND,
Gen'l Sup't Transportation.
F. DE FUNIAK,
Chf. Eng. & Sup't Machinery,
Louisville & Great Southern R. R. Line.
D. B. ROBINSON, *Supt New Orleans & Mobile R. R.*
E. D. FROST, *Gen'l Manager New Orleans, St. Louis & Chicago R. R. Line.*

To appreciate the extent of this munificent courtesy of the foregoing railroad officials, we may mention that the excursion train was made up of two regular coaches, two Pullman sleepers, and the Directors' car of the Louisville & Great Southern R. R. Line. The train was under the care of special conductors, the right of way was granted it throughout, and it waited at New Orleans an entire week to convey the party back to Louisville. The route in going was *via* Nashville and Mobile; in returning it was *via* Jackson, Miss., to Grand Junction, and thence over the line from Memphis to Louisville. The Western members and guests were furnished free transportation from Chicago to New Orleans and return, by the kindness of the Illinois Central R. R. Co. and the New Orleans, St. Louis & Chicago R.R., Co., a total distance of 1,860 miles, and in whichever direction it was decided by any of the party that they would return home, free transportation was immediately procured.

In New Orleans every facility for seeing the city was provided by the local committee, and they, with many of the residents, were indefatigable in contributing to the enjoyment of the occasion. Capt. Eads' generosity in providing steamers, and such a capable director of ceremonies as Mr. Corthell, has already been referred to, while to the U. S. officers on duty in New Orleans the visitors are very much indebted for the considerable share which they took in entertaining them wherever and whenever they had the opportunity.

Heretofore the Conventions have been held in cities to which the members came by various and widely different routes of railway; hotel accommodations were at the selection of each individual; the Convention was occupied largely with the reading and discussion of papers, the excursions were necessarily somewhat divided, and after they were over the members hurried away as they came, by different routes, knowing but little more of each other than before they met. In this last Convention there were many innovations on this method, and, as we believe, to the profit of all alike. The number in attendance was, we are told, the largest of any Convention yet held by the Society; there was a unanimous sentiment prevailing in favor of an early adjournment of the Convention, and the improvement of all the time possible in becoming better acquainted with each other, and so interchanging opinions more freely than could, or would, be done in formal discussions; the peculiar nature of the excursions, consisting of long intervals of time passed on board the cars and steamboats contributed to the more intimate acquaintance with each other, while the latest innovation of admitting ladies to the Convention dinner and to a prominent share in the pleasure excursions following, all contributed to render this meeting of Engineers an occasion of peculiar enjoyment and relaxation from the usually very practical and severe duties in which they are generally engaged.

Where the next Convention will be held will not be known for some months to come; we hope to see by the time that it does meet, a large increase in membership and influence of all the societies, and a very general desire of the profession to be present at this Annual meeting of the representative Society of the Country, and by so doing give their influence towards the exaltation of Civil Engineering to its proper place as the leading profession of civilization.

We are pleased to notice that the Franklin Institute have honored Mr. P. H. Dudley's Dynagraph with a gold medal.

The city of Detroit has failed to secure legislative sanction to the scheme of offering $500,000 bonus to a tunnel company. Those in favor of a tunnel are now endeavoring to secure private subscriptions and co-operation.

Personal.—John Ryall, C. E., has been re-elected City Engineer of Fort Wayne, Ind.

The Lehigh R. R. company are said to meditate following the line of action of the Reading company towards those locomotive engineers who belong to the Brotherhood, that is, creating an insurance fund for heir benefit, and then giving them notice to withdraw from the Brotherhood or leave the R. R. company's employment.

At 3 o'clock Thursday, Gen. Sooy Smith, P. B. Wight, and Edward Burling, presented their report on the Rockford calamity, at which time after being read, the jury decided to fully examine each of the above named gentlemen individually, not in the presence of each other. The report of the Committee is written, and is an elaborate document. It took over an hour to read it, and it went into every detail of the building, and is in itself a most complete description of the causes of the accident. This report, while pronouncing the plans of Gay radically defective, at the same time fully realizing the extreme delicacy of their position, show that Mr. Richardson, Mr. Latham and the county Board were also in a measure to blame.

We hope to be able to give the whole or part of this report next week.

CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

NEW ORLEANS, *Friday, April 27, 1877.*

At 10 A. M., the *LaBelle*, with 128 excursionists on board, backed out from the levee and steamed away towards the Gulf of Mexico. The weather was unexceptionable; the scenery was novel to most of the party; there were several points of historic interest to be passed; the invited guests from New Orleans were assiduous in pointing out the objects of interest along the river and in explaining the methods of draining and cultivating the plantations; the opportunity for more intimate acquaintance among themselves was quickly improved by all present, and the good feeling thus engendered at once banished all sense of monotony and gave to this crowning excursion of the Convention a constant charm from first to last which will long be remembered by all those who participated in it. The following is a list of the excursionists with their addresses so far as we were able to obtain them:

Frank C. Allen, 66 Vernon st., Boston; James Archibald, Ch. Eng. D. L. &. W. R. R., Scranton, Pa.; Frederick Brooks, Asst. Eng. Boston W. W.; John Bogart, Treasurer, and acting Secretary, of Convention American Society of Civil Engineers, and Mrs. Bogart, 36 Union square, New York; Mr. and Mrs. Balantyne, N. O.; Gen. G. T. Beauregard, Jas. Browning, Louisville; H. E. Stevens, C. E., St, Paul, Minn.; Louis G. F. Bouscaren, Asst. Eng. C. S. R'y, Cincinnati; William B. Cogswell, Mine La Motte, Mo.; Elmir L. Corthell, Asst. Eng. South Pass Jetty Works, Port Eads, La.; David W. Cunningham, Asst. Eng. Boston W. W., South Framingham, Mass.; Oliver E. Cushing, Agt. Lowell Gaslight Co., Lowell, Mass.; Frederick De Funiak, Chief Engineer and Supt. Road Department, L. & N. R. R. and Mrs. De Funiak, Louisville, Ky.; M. T. Endicott, C. E. U. S. Navy, New London, Chas. A. Ferry, Asst. Eng., 18 City Hall, New Haven, Conn.; Desmond Fitzgerald, Supt. Cotchituate W. W'ks, Boston, Mass.; John E. Earley, Res. Eng., C. S. Ry., Somerset, Ky.; Henry Earnshaw, 4th and Race sts., Cincinnati, O.; Clarence S. Ellis, City Hall, Boston; Charles E. Emery, 7 Warren Street, N. Y., Albert Fink, 226 Broadway, Louisville, Ky.; Henry Fink; J. Foster Flagg, City Eng. Meadville, Pa.; Caleb G. Forshey, U. S. Engs. office, 23 Rampart st., New Orleans, La.; Wilbur F. Foster, Burns' Block, Public Sq., Nashville, Tenn.; James B. Francis, Ch. Eng. Locks and Canals, Merrimack River, Lowell, Mass.; Sidney T. Fuller, Ch. Eng. P. W. & B. R. R., Phila.; John Griffen, (Clarke, Reeves & Co.,) Phœnixville, Pa.; A. B. Hill, Asst. City Eng., 18 City Hall, New Haven; Arthur Hobart, Aetna Woolen Mills, Boston; Clemens Herschel, 66 State st., Boston, Milton G. Howe, Ch. Eng. H. & T. C. R. R., Houston,

Texas; Charles W. Howell, Major of Engs. U. S. A., New Orleans; William E. Kelley, New Brunswick, N. J.; Eugene C. Lewis, Sycamore Mfg. Co., Nashville, Tenn.; Thomas D. Lovett, Cons'g and Prin. Eng. C. S. R'y, 70 West 3d st., Cincinnati; Charles MacRitchie, 105 Wisconsin st., Milwaukee, Wis.; Niles Meriwether, Chief Engineer, N. O. St. L. & C. R'y, McComb City, Miss.; P. N. Moore; Robt. Moore, 1221 St. Ange av., St. Louis, Mo. Edward S. Philbrick, Cons'g Eng., 12 West st., Boston; Franklin C. Prindle, Sec'y Am. Dredging Co., 10 South Delaware av., Philadelphia; Alfred L. Rives, Gen. Supt. M. & O. R. R., Mobile, Ala.; W. Milnor Roberts, Ch. Eng. N. P. R. R., 23 Fifth av., New York; William Rotch, Ch. Eng. Water Works, Falf River, Mass., Mrs. Rotch; Wm. H. Searles, Div. Eng. N. Y. State Canals, Rochester, N. Y.; Joseph S. Sewall, St. Paul, Minn.; Wm. Sooy Smith, Maywood, Ill.; Charles H. Strong, 101½ Water st., Cleveland, Ohio; Frederick W. Vaughan, V. Pres. Louisville Bridge & Iron Company; and Mrs. Vaughan, Louisville, Ky.; Charles D. Ward, 36 Hudson street, Jersey City, N. J.; Henry D. Whitcomb, Ch. Eng. James River Improvement, Richmond, Va.; Henry M. Wightman, As't City Eng., City Hall, Boston; William H. Wiley, (John Wiley & Sons) 15 Astor Place, New York; William E. Worthen, 63 Bleecker st., New York; Arthur S. C. Wurtele, 10, Jay at., Albany, N. Y.; Arthur Beardsley, Prof. Mechanics and Engineering, Swarthmore College, Swarthmore, Pa. Charles B. Brush, (Spielman & Brush) 40 Hudson st., Hoboken, N. J.; Emory C. Davis, Northampton, Mass.; Robert Fletcher, Prof. Civil Engineering, Thayer School, Dartmouth College, Hanover, N. H.; Charles M. Harris, 61 Broadway, New York; Horatio Seymour, Jr., Utica, N. Y.; Arthur Spielmann, (Spielmann & Brush), 40 Hudson st., Hoboken, N. J.; Lorenzo M. Johnson, Eng. K. & D. M. Ry., Keokuk, Iowa; Thomas J. Long, Asst. Eng. Dept. of Docks, 28 West 60th st., New York; Alfred Noble, 85 Washington av., Detroit, Mich.; Frank O. Whitney, Boston; Samuel Whinery, Div. Eng. C. S. Ry., Chattanooga, Tenn.; E. A. Doane, Meadville, Pa.; W. H. Newton, Chicago; Chas. R. Flint, New York; D. E. McComb, C. E.; Washington; Frederick W. Merz, Louisville, Ky.; Sanford Horton, New York; E. Powell, M. D., Chicago; J. H. Gardner, New Orleans, La.; B. M. Harrod, N O.; H. P. Davock, C. E., Detroit; R. L. Engle, Chattanooga; Prof. W. Watson, Boston; Arthur Macey, N. Y., city; Prof. L. E. Cooley, Evanston, Ill.; Major C. H. Boyd, U. S. Coast Survey.; J. A. Hayward, C.E. U.S.Eng., N.O.; A. S. Tyler, Lowell, Mass.; Benj. McLeren, St. L. & C. R. R., N. O.; C. M. Perin, Supt. N. O. & C. R. R., N. O.; L. S. Olmsted, Jacksonville; B. F. Morse, City Engineer, Cleveland, O.; Wm. A. Smith, *Railway Review*, Chicago; O. B. Green, Chicago; F. W. Clarke, C. E., Chicago; J. F. Goodhue, C. E., Chicago; A. B. Clifton, N. O.; T. S. Hardee, N. O.; Mr. and Mrs. Karner, N. O.; Miss Parker; Wm. Washburn, N. O.; Messrs. Morgan, Mathews, Owen, Tomlinson, Ward well, of New Orleans; Mrs. Underhill, Chicago; Bradish Johnson, N. O.; Richard Scriven, Civil Engineer; James Freret, Architect and Civil Engineer, N. O.; Col. A. F. Wrotnowski, N. O.; Frank H. Taylor, Special Artist of *Graphic*, Philadelphia; W. H. H. Judson, New Orleans *Times*; Mrs. Judson, and Miss Judson; Judge J. H. Kennard, N. O.; A. M. Granger N. O.; J. W. Putnam, New Orleans & Mobile R. R., Mrs. Putnam, Pascagoula; Miss Pitkin, Geo. H. Frost, ENGINEERING NEWS; Miss Hunt, Chicago.; Mrs. Mason and Miss Mason, of Ann Arbor, Mich; Owen Meriwether, Civil Engineer, Memphis; J. A. D'Hemecourt, City Surveyor, N. O.; Geo. A. D' Hemecourt, N. O.; Lieut. Chas. E. L. B. Davis, U. S. Engrs. N. O.; Leon Fremaux, Asst. City Engineer; W. A. Belknap, Louisville, Ky.

The most interesting historic ground passed during the forenoon was the scene of the battle of New Orleans. At 2 P. M., the *LaBelle* came to a landing at Magnolia Plantation on the west bank of the river, where the party were enthusiastically and cordially welcomed by its hospitable proprietor, Col. C. B. Lawrence, who had prepared a most generous lunch for their refreshment, and who placed all the resources of the plantation at their disposal for their entertainment. After the usual opening salutations of such an occasion, and the hearty enjoyment of the good cheer provided for them, the party were invited to ramble over the place at their pleasure; the ladies were taken in carriages through the orange grove, which is the largest but one on the river, and shown so much of plantation life as could be shown in a short time: the gentlemen explored the sugar house which was a most extensive affair and filled with ponderous machinery; they found the four great English steam plowing engines, and plows, of Fowler's manufacture, of considerable interest, and after these a hasty look at the plantation buildings, and the field hands at work in the cane-fields, after which all came together again in the host's hospitable dining hall where some very happy speeches were made by W. Milnor Roberts on behalf of the engineers, and in return by Col. Lawrence, General Beauregard, and Bradish Johnson, Esq. There were also a number of very charming ladies belonging to Col. Lawrence's household, who added very materially to the other attractions of the place, and whose acquaintance, we have no doubt some of the younger men of that boating party would like to renew during their summering at the north this season.

In consequence of the freshening of the weather, at nightfall the Captain of the *LaBelle* deemed it prudent to "tie up" till morning at the north end of the "Jump" a broad crevasse, and at which point the Mississippi widens to about 8,000 feet. The next morning some of the wakeful ones reported having seen a few mosquitoes flying about the cabin during the night, but it was generally ascribed to nervousness on their part, although it was unanimously voted that sleeping along side of a Louisiana swamp was not a pleasure to be courted very often. At day-break the boat was once more under way and shortly after breakfast the party landed at Eadsport, the new and rapidly growing seaport city of the Gulf. The most complete accounts of the work done at South Pass by Capt. Eads, at present in print, have been published in Vols. III and IV of ENGINEERING NEWS; for the best description of the inception of the work, the construction of the "mattresses" and the effects of the jetties in deepening the South Pass from 7 feet to very nearly 21 feet, in less than two years time, we must refer our readers to the very interesting article on pages 180 and 181; Vol. III, by D. W. Bowman, C. E. At page 244, Mr. J. A. Hayward, C. E., of New Orleans, has taken an opposite view of the subject from that of Mr. Bowman, and his article is illustrated by a plat of the passes; in the current volume the works at the head of the passes are illustrated, and a letter from E. L. Corthell, the energetic and efficient Assistant Engineer in charge, explains their uses, while the more recent article of Mr. Schmidt describes the method of obtaining the slope of the river by leveling. The jetties at South Pass are as yet an experiment, the success of which must be determined by time. A great deal has certainly already been accomplished by Capt. Eads and his boldness in undertaking so vast an enterprise under such difficulties, and his energy and courage in carrying it forward to its present results deserve the highest commendation and a generous pecuniary reward, and it cannot but be the sincere wish of every one who realizes the great advantages which must accrue to southern commerce by the permanent maintenance of a deep channel from the Gulf of Mexico to New Orleans and other river ports, that the enterprising contractor will make a complete and lasting success of the undertaking in which he is engaged. Col. W. Milnor Roberts and other eminent engineers who have visited the works at South Pass and who have made the subject of the hydraulics of great rivers the study of a lifetime, are positive in expressing their confidence in the efficiency of the present system of jetties; to time and the great river itself must be left the final solution of the problem.

The engineers' office at Eadsport was the rallying place of the party, and Mr. Schmidt, the very able assistant engineer in charge, soon found business enough in trying to answer a continuous stream of questions about current velocity, various depth contours, profiles, sections, mud-lumps, the scour of the river, to say nothing of a multitude of other subjects upon which he stood a most searching cross-examination by men who were familiar with the subject of hydraulics and who had come to South Pass to gain information. But Mr. Schmidt had learned the Mississippi pretty thoroughly and for every question had an answer, and a map to illustrate it.

The great river is an immense subject for study and the accounts of the phenomena already noted by its indefatigable human antagonists at South Pass would fill a volume; the working force is, however, so small that there is no time for anything but the regular daily work and therefore much that would be of general interest must remain with the engineers in charge until they find the time to give their brethren of the profession the benefit of their observations. We hope, however, we may from time to time be allowed to give to the readers of ENGINEERING NEWS an account of what is being done in the conflict between human skill and energy and the great river that drains a continent in its passage to the sea.

As an indication of the variety of observations that have to be made constantly and daily placed on paper for preservation and study, we note the following as the arrangement of drawings in the office:

Charts of Jetty Channel.

Profiles, plats, etc., referring to construction of Jetties.

Profiles and Cross-sections at the Jetties.

Profiles, Plats, etc., referring to Works at Grand Bayou.

Profiles, Plats, etc., referring to construction of Works at Head of Passes.

Profiles and Cross-sections at Head of Passes including sections in South Pass, Pass A l'Outre, and S. W. Pass.

Gauging Notes and Surface Slopes.

Under these headings were maps innumerable, in colors and in lines, and to be able to read them intelligently requires considerable study and practice. The working hours of the engineer corps are from 7½ A. M. till dark; it is work all the time, and every man must be in readiness to respond to calls upon him at any hour, day or night, or Sunday. A complete journal of every day's work is kept and it is usually the case with the engineer corps that after working on the river all day that they must continue their labors far into the night in recording their notes and studying the problems that are constantly arising for solution. A telegraph report of work is forwarded daily to Capt. Eads, who, wherever he is, is watching the great work he has undertaken.

All of the visiting party, who chose to go were taken on tugs to make a close inspection of the jetties. The excursion to South Pass was under the direct supervision of Mr. E. L. Corthell, from first to last, and certainly that gentlemen, Mr. Schmidt, his first assistant, and Mr. Karner, the cashier of the Jetty Company, left nothing undone to make the excursion alike pleasant and profitable to all.

After some hours thus agreeably spent at Eadsport the party were taken on board of the U. S. Revenue cutter, Jno. A. Dix, and the large steam tug, E. B. Ward, and after a trip on the Gulf and up South West Pass were re-embarked on board the *LaBelle* at the Head of Passes about 5 P. M., on Saturday. The time spent on the Gulf of Mexico was especially enjoyed, and notwithstanding the odious "ground swell" peculiar to those waters, when the two parties met on board the *LaBelle* to compare notes of experience, alligators, etc., everybody had proved to be regular "old salts" in resisting the peculiar influence of "ground swells," except—we are sorry to mention it—the amiable and genial chairman of the Convention, who lost his legs completely soon after turning the corner of the west Jetty, and did'nt regain them until we sighted the first alligator in the placid waters of the South West Pass. We noticed several others, however, looking long and steadily into the blue waters of the Gulf, but supposed they were watching for sharks and porpoises. After supper the company listened to short speeches from Col. W. Milnor Roberts, Gen. Beauregard, E. L. Corthell, and Judge Kennard, of New Orleans; votes of thanks were passed for the hospitalities which had been extended to the Convention, and after three cheers for the jetties, Capt. Eads and Mr. Corthell, and the singing of the "Star Spangled Banner" the company retired for the night, to a sleep undisturbed by the pestiferous mosquito, and from which they were aroused by the arrival of the boat at the New Orleans landing at 8 A. M. As engineers are all church-going people, so they all went to church in the forenoon, and remained quietly in the hotel parlors all the rest of the day, thus setting a good example for the wicked people of the Crescent city. The

influence of Moody and Sankey on the visitors from Boston was especially noticeable in this respect.

On Monday many of the visitors left for their homes; a considerable party visited the Bonnet Carre Crevasse; others visited objects of interest in the city; in the evening there was another trip on the river, in the "Protector" and a visit to the Monitor Canonicus lying in the river, where the party was most politely received by the officers in command and shown through every part of the vessel. The next morning about thirty of the party left for Galveston in company with Capt. Howell, U.S. Engineer, to inspect the government improvements at that place; others left by the regular Chicago train at 7½ A. M., and the eastern members and a part of the Chicago company left at 10 A. M. on the special train for Louisville, which returned to that city over the New Orleans & Chicago Railroad to Grand Junction, thence over the Louisville & Memphis road to Louisville, arriving in this latter city at 5 P. M. Wednesday. In passing over the New Orleans & Chicago road, the party dined at McComb City, where a most excellent repast had been provided for them by W. P. McKinley, Supt. Louisiana Division, who accompanied the party from New Orleans to Canton and devoted himself to providing for the comfort and entertainment of the party while in his division. The run from Grand Junction to Louisville was made in about 10 hours; the line traverses the finest region which we passed through during our absence, and under the superintendence of its very efficient corps of officers, the Louisville & Memphis R. R. is now one of the finest roads in the country, and the condition of its track and rolling stock is being steadily improved. The road crosses the Tennessee river by a magnificent iron bridge of eleven spans of 200 feet each and a draw, erected by the Louisville Bridge Company, who we soon learned, erected all the bridges on the line, and who are perhaps the leading bridge builders of the Southern States. A number of the party were allowed to get off the train at the west end of the bridge over the Tennessee, and with Albert Fink, the well-known Chief Engineer of the Bridge Company, and Mr. Vaughan the Vice-President, to answer any questions, proceeded to inspect the structure while walking over its entire length.

At Lebanon Junction the party found dinner awaiting them, and in this connection we think it is but just to state that at this eating station we found the most satisfactory entertainment with which we had met anywhere on the whole route over which we passed during the week, not excepting even the St. Charles Hotel of New Orleans.

At Cane City a detachment of the party left the train for a flying visit to the celebrated Mammoth Cave only nine miles distant; the balance of the party now considerably reduced in numbers kept on to Louisville, and thence homewards by the respective routes thither.

The Convention from first to last was an exceedingly enjoyable and profitable one, and we have no doubt will be remembered with pleasure by both the members of the Society and their guests, who were so fortunate as to be participants on the occasion.

THE PERMANENT SUPPLY WATER WORKS OF BALTIMORE.

One of the greatest engineering works now in progress is that to supply the city of Baltimore with water, and the gentlemen in charge of it have been so busy pushing it forward that they have had very little time to talk about it: in consequence of which not many people outside of the city know anything of it, and comparatively few have any idea of the immensity and difficulty of the works that are now so quietly progressing to supply them with an almost unlimited supply of the necessary article of water. One of our correspondents lately called on Mr. Robert K. Martin, the engineer in charge, who was so obliging as to show him over the line of works, and we are thus enabled to lay the following particulars before our readers.

Baltimore is at present supplied with works having a capacity of about 15,000,000 gallons a day, which comes from Jones' Falls to Lake Roland, whence it is brought by a conduit 3¾ miles long to Hamden reservoir and Druid Lake. From the latter, which is 53 acres in extent and 217 feet above tide, one portion of the water is raised by powerful steam pumps to a high service reservoir 350 feet above tide, for supplying the highest region of the city; a second part is supplied direct to the mains; and still another portion is allowed to pass to Mount Royal reservoir, which is only 150 feet above tide so as not to give too high a pressure to the lowest portion of the city.

The supply having been found to be insufficient in the summer season, it was resolved to increase it temporarily by erecting, near the Gunpowder River, a pair of Worthington's duplex compound pumping engines, capable of raising 10,000,000 gallons a day from that river, over a hill 265 feet high, to Roland Run, a tributary of Jones' Falls above mentioned. This arrangement, however, was not sufficient for some of the more enterprising of the Baltimoreans, and a new plan was devised; and it is now being carried out, notwithstanding considerable opposition by interested parties, by the capable and energetic civil engineer of the Water Commission, Mr. R. K. Martin, who had charge of the previous works, erected in 1858. The source of the new supply is the Gunpowder River, which at about nine miles from Baltimore makes its nearest approach to the city, as at this point it takes a bend in another direction. Advantage is taken of this turn to form a dam across the stream, and so form a storage lake, which will, it is believed, be capable of supplying the city with 175,000,000 gallons of water every twenty-four hours. This lake will be from 500 to 1,000 feet wide, about 20 feet deep on the average, and will extend up the Gunpowder a distance of about 5 miles through the most picturesque scenery, which is constantly changing, as the river and the valley through which it runs pursue a very devious course between ranges of precipitous, wooded hills, from where it leaves the open country near Meredith's Ford bridge, which forms the head of the lake. To facilitate operations, a road 10 miles long, about 30 feet wide, and about 10 above the intended level of the lake, has been cut in the sides of the hill on each side, which will no doubt be utilized hereafter as a pleasure drive by the lovers of beautiful scenery.

At the lower end of the site chosen for the lake, two hills jut out into the valley, leaving but a comparatively narrow place, of which advantage is taken to form a dam which will raise the water about twenty feet above the natural level of the river. In one of these hills is the mouth of the tunnel, hereafter referred to, from the side of which a dam will be built having an overfall of 300 feet and a wing of 190 feet, that will extend into the opposite hill. This dam will be of the most substantial character, of heavy stone laid in hydraulic cement. The stone work will be 31 feet high and about 65 at the base, having its foundation on the solid rock; and it is estimated that about 20,000 perches of stone will be required for this part alone. The face of the overfall will be built of large blocks from three to four feet in depth; and to prevent any undermining, an apron is to be cut below the overfall resting four feet below any of the other foundations. The other side of the dam will be protected by a backing of 165 feet of puddle clay, gravel, and riprapping. The parapet walls will rise 12 feet above the overfall, and will be level with the floor of a gate house that is to be erected at the tunnel end of the dam. At the gate house begins the tunnel, which is to carry the water to Lake Montebello. This tunnel is nearly seven miles long—36,510 feet—and is therefore the longest in the country. The bore is circular in shape and is 12 feet in diameter. Over five miles of it will be through hard gneiss, which is being cut with drills driven by manual labor, as the contractors think that, owing to the comparatively small area of the tunnel, the power drills are not economical enough to pay them for the cost of the necessary machinery. A portion of the tunnel is being cut through softer material—a kind of limestone, that crumbles into powder by the force of the explosion when blasted. This part of the tunnel will have to be bricked; but where the gneiss occurs, the brickwork will be dispensed with, except in some localities where there are bad breaks and crevices in the rock, and at the bottoms of the shafts which will, when the tunnel is completed, be arched over with masonry 6 feet thick, to withstand the immense pressure of the loose earth filled in above.

To facilitate the operations in the tunnel, fifteen shafts, from 65 to 300 feet deep, have been sunk, most of which are down to grade; and in some of them considerable work has been done on the tunnel. But owing to the hardness of the rock for the larger portion of the distance, very fast progress cannot be made—only about a running foot of tunnel per shift of 12 hours, or two feet per day, as in tunneling night and day are alike so far as work is concerned, the only light in either case being that obtained from the small lamps attached to the miners' hats. As before stated, the contractors employ manual power for drilling, which, in the hard work, is done by task work—thirteen feet per shift being the miner's task. The holes are bored 30 inches deep, and an eight ounce cartridge of giant powder (nitro-glycerine and sawdust) is used in each hole, at which rate about 7 lbs. of powder, at 40 cents per lb. is used for each running foot of hard rock tunnel, making for the five miles through the gneiss nearly $74,000 for explosive alone, to say nothing of that used in the other portions of the work.

The shafts are from 8 x 17 to 8 x 20 feet inside the timber work, which, when used, adds about 30 inches to the above figures; and as fast as they are completed they are fitted with improved safety cages to prevent accidents from the hoisting mechanism; but they have only the ordinary tipping bucket until the shaft is down to grade. The exhaust from hoisting engines is utilized to create a draught in a pipe, the mouth of which is near the heading, and by this means ventilation is secured in the tunnel.

In the limestone portion of the tunnel, between shafts 1 and 2, the stratum makes an eccentric dip, leaving a "pocket" of mud which, as the miners were working towards it, suddenly ran into the tunnel, overwhelming and suffocating one poor fellow who had been driven by it against the timbers; but the remainder of the workmen managed to escape. In this, as in some other sections, the water forms a great hindrance to operations, a spring being found here which keeps a steam pump of a capacity of 200 gallons a minute constantly at work, while about the same quanity of water percolates through other crevices in the rocky sides of this section of the tunnel and has to be removed by another pump of the same size. The same trouble occurs in other shafts, especially No 5.

To make the necessary observations required to properly line and level the tunnel, a straight line has been made over the tops of the hills and through the woods, and three observatories have been erected for this purpose. As an instance of the great care taken by Mr. Martin in this matter, it may be stated that these structures are double, consisting of an inner tower (on which the instruments are placed) protected from atmospheric and other influences by an outer one, entirely detached from the other, on which the engineer stands when making his observations.

At the lower end of the tunnel is to be located a reservoir, to be known as Lake Montebello, which is being formed by damming up a valley admirably suited to the use to which it is being put. The upper and lower ends of the valley, forming the east and west sides of the reservoir, will be closed up with dams of stone and earth, 450 feet wide at the base and 100 feet at the top, with each end embedded in the hills at the sides, so that the greatest possible strength may be obtained; for this is one of the most critical pieces of construction along the whole line, and these dams will have to sustain the pressure of 600,000,000 gallons of water. The north and south sides of the valley, about 3,500 feet each, will form the other sides of the reservoir, which, when completed, will have the appearance of a natural lake, and will have a superficial area of about 80 acres and a depth of at least 30 feet. The sides will be finished with riprapping, and the top will be surrounded by a fine road 1½ miles long and from 60 to 80 feet wide, divided from the reservoir by a neat and substantial iron fence.

There being a stream running through this valley whose water is too impure to be used, a drainage tunnel, 2,870 feet long and of 9 feet diameter, had to be made to carry it away, which tunnel will also serve to take off the surface drainage, and to empty the reservoir, should it be required. From this reservoir, another tunnel, 2,600 feet in length and 12 feet in diameter, is now in course of construction. This tunnel is cut through soft material, and therefore requires strengthening with brickwork laid in hydraulic cement. Where the tunnel is of the right character, the top arch is three bricks thick and the invert below the spring line two bricks, with a proportionate backing from 18 to 24 inches above the

spring line built in against the timbers or the rock wall of the tunnel. In the soft places there is an additional ring of brickwork added and the backing is proportionately increased. In all cases, the arch is packed over the top with clay well rammed in. The brick work in this, as in the main and drainage tunnels, requires to be done with the greatest care, as it has to stand not only the outside pressure of the immense weight of material above it, and in railroad tunnels, but also the internal pressure of the water within, which is always searching for weak spots to break through, and it is therefore being done by the day. It is estimated that about 12,000,000 bricks will be used in all the tunnels.

One portion of this tunnel passes beneath a well, the bottom of which is only four feet from the top of the tunnel; and yet the water of the well has not been drained, and it continues to furnish its usual quantity of water, notwithstanding that another well, 300 feet from the tunnel, was almost immediately drained and has now no water whatever.

At the end of this tunnel will be a gate house from which the water will pass into six pipes of 48 inches diameter each, by which it will be conveyed to the city limits, and there connected with the present system of mains for distribution throughout the city.

Along the line of the work have sprung into being several temporary villages for the miners and laborers, showing styles of architecture that one would hardly expect to find so near a great city, varying from the tolerably comfortable offices of the contractors to that of the squalid log huts of the negro laborers on the storage lake, with a single room that is half below ground and half above. Many drinking shops have also been built on the line, or rather as near to it as they can be built (for the engineer will not allow them on the city property), in which the men squander their hard earnings after each pay day, and so unfit themselves for their labor as to cause no small delay to the progress of the work.

Unlike the officials of some other cities that may be named, those of Baltimore appear to have a fashion of completing their public works without exceeding the appropriations for them. This was the case with their city hall, inaugurated a year or two ago, and it appears as if it would be the same with the water works. The amount appropriated for this purpose is $4,000,000; but the engineer in charge, who is doing his best to cut down the expenses all he can without depreciating the quality of the work, thinks the whole improvement can be completed at a cost of very little, if any, over $3.000,-000. About 1,500 men are employed—common laborers getting $1.25 per day and miners $1.50. It is expected that the whole work will take about three years to finish, and Baltimore will then have a natural flow through the tunnel that will supply it for generations to come with all the water for ordinary purposes that can be used or wasted, as the river at the point tapped is 170 feet above mean tide, and consequently will give water to nearly all the houses in the city, except in the extreme northwest section, for which the water will still have to be pumped into a high service reservoir.

Mr. Martin is assisted by Mr. C. P. Manning, consulting engineer, W. L. Kenley, chief assistant, and seven resident engineers, Messrs. R. B. Hook, W. R. Warfield, C. O. Swan, C. T. Manning, O. H. Balderston and C. A. Hook, who are named in order of the work they have in charge, beginning at the storage lake. The contractors, also named in the same order, are Messrs. Condon, and Co., Fenton and Allan, Bruce and Patterson, L. B. McCabe and Brother, J. Donohue and Brother, and J. E. Eschback.

From this cursory sketch, some idea of the magnitude of the work in which the city of Baltimore is engaged may be obtained—a work alike honorable to the public spirit of her citizens and the gentlemen engaged in its construction.—*Scientific American.*

ON THE CONSTRUCTION AND WORKING OF THE ST. GOTHARD RAILWAY.*

BY G. PACHO.

The execution of the St. Gothard Railway, the design of which was to place Italy in direct communication with Eastern Switzerland and with western Germany, is opposed by serious difficulties. A loss of at least £4.-000,000 sterling is threatened, according to the calculations of the last-appointed Engineer, M. Hellwag. The operations have been suspended, the staff discharged and only the works of the great tunnel are being carried on. From the report of the directors of the company it is possible to form an idea of the cause of the mischief.

After a long contest between the promoters of the three Alpine lines of St. Gothard, Lucomagno, and the Splugen, the St. Gothard valley was finally selected as the line which appeared to promise most advantage at the least cost.

By an agreement dated the 28th of October, 1871, the delegates of Switzerland, Italy, the North German Confederation, Wurtemburg, and the Grand Duchy of Baden, united their efforts to overcome, by means of a Swiss railway through the St Gothard pass, the obstacle, presented by the Alps, to the junction of the railways of Central Europe with those of the Italian peninsula.

After an examination and survey, the details of which occupy two volumes published by the Italian ministry, it was estimated that the total cost of the undertaking, including the approaches, the tunnel, and the complementary lines, would amount to £7,480,000. In order to attract private enterprise to the work it was considered necessary that the sum of £3,000,000 should be subscribed by the states interested in the communication, as an absolute gift, in which case it was anticipated that the remaining £4,480,000 might be obtained by subscription. The estimated revenue was given at £252,-480 per annum. It appears, however, that the preliminary surveys were far from accurate. The International Commission contented themselves with prescribing that the works should be executed with the utmost economy.

The St. Gothard Railway Company was formed on the above basis. The capital was subscribed. A contract was entered into with M. Favre, the contractor for the Mont Cenis tunnel, to execute the tunnel under St. Gothard, and the work was commenced. The network of railway which it was intended to construct amounted to a total length of 164 miles. Soon afterwards, however, important deficiencies were remarked in the estimates. In April, 1874, the Chief Engineer, Gerwig, presented a further detailed estimate of the cost of construction, which exceeded by about £1,168,000 his estimate of 1872. M. Gerwig resigning his post, was succeeded by M. Hellwag, who considerably modified the plans of his predecessor, and arrived at an estimate exceeding that of the International Commission by £2,412,440, making the total cost of the line amount to £9,892,440. The chief difference in these estimates arose in the approaches to the tunnel. M. Hellwag's plan was based on the principle of keeping the line near to the bottom of the valleys, so as to maintain communication, at the stations, with the existing roads, and then to ascend the scarp of the mountains, at the entrance of the tunnel, by a series of zigzags, or, as he called them "helicoid volutes," constructed at the most appropriate points. It was expected that this method would prove the cheapest. The result of the detailed plans was however, this increase of £2,412,440 on the former estimate.

Without entering into the details of this considerable difference, the author proceeds to point out that the cost of the two lines in the valley of the Ticino, now open, namely the Biasca-Bellinzona-Locarno, and the Lugano-Chiasso sections, which had been estimated by the International Commission at £742,400, amounted, or would amount when complete (after allowing for a loss on working in the first instance, before the completion of the entire line), to £2,064,000; a difference which, in the opinion of the members of the General Committee of Direction of the St. Gothard line, is "truly colossal."

The reasons for this extraordinary excess, according to Signor Pacho, become apparent on a perusal of the report of M. Hellwag; who is accused of having entirely lost sight of the real object of the railway, that is to say, the formation of a route for transit from Italy to Germany. To give an idea of the scale of magnificence adopted, it is mentioned that the provision for sidings and accessory lines on this section, which had been calculated by the International Commission at 20 per cent. of the length of the mileage, amounts, according to M. Hellwag's plan, to a length equal to that of the total mileage of the section. This explains how an estimate of £742,000 has been swollen to one of £2,-064,000.

The report of the directors, drawn up under these circumstances, remits to the Federal Council of Switzerland the task of entering into fresh arrangements with the other interested states, for the purpose of raising the additional funds now found to be necessary for the completion of the line. To meet the responsibility of the directors, it is calculated that at least the original subscription, or free gift, of £3,000,000 must be increased by the further sum of £4,094,840, a demand which appears to the directors difficult to urge.

To give an idea of the differences shown by the revision of the estimates, the following particulars are cited. The estimate of the International Commission for the cost of the general administration, comprising the expenditure incurred in raising the capital, and the expenses of the central administration, was £74,156. That of M. Hellwag, in 1876, amounted to £258,880 The cost of surveys, in the former estimate, was set down at £100 per mile, amounting to £26,540. In the latter it stands at £268 per mile, giving an amount of £74,200. For the purchase of land the first estimate allowed £179,760; the second, £456,960. For the station at Lucerne, and the fourteen sections of line on the Swiss side of the Alps, the estimate of the Commission was £3,840,404; that of M. Hellwag £6,795,-124. For the tunnel itself the additional cost was only 2½ per cent. For the three sections of line on the Italian side, 17½ per cent. was added to the former estimate. The general account of cost, according to M. Hellwag, was as follows:

Reimbursement of preliminary expenses..	£20,200
Raising capital	244,800
General administration	138,472
Interest to opening of line.....	1,309,800
Engineering (technical direction)	459,968
Actual construction	9,401,620
	11,574,860
Estimate published by Italian Government.	7,480,000
Deficit.....	£4,094,869

To this sum, however, a considerable addition has to be made for interest during the time occupied by the suspension of the works. As the total length of line composing the entire network was 164 miles, this gives a cost of £70,578 per mile, whereas the original estimate was £45,610 per mile.*

Starting from the above data, and considering that the deficit of £4.094,860 could not well be covered by the issue of shares or debentures at less than six per cent., and that any addition either to the capital raised, on the one hand, or to the time consumed by suspension of works on the other, must add to the final cost of the undertaking, there seems every reason, the author thinks, to anticipate that, without the aid of a considerable subsidy from the states interested, the deficit will amount to at least £4,400,000. It is possible that the original estimate was too low. But it was based on the experience previously obtained in the execution of Alpine lines, the prices of which had been adopted by the Commission as normal.

The remainder of the paper is taken up with a detailed examination of the economies which might be effected in the execution of the works; and by the substitution of steamers on the Lake of Lucerne for the construction of certain portions of the line. The gradients vary from 1 in 122 to a maximum of 1 in 26.77, the mean ascent from the station of Silencia, on the northern side, to that of Goschenen. On the Italian side the mean gradient is 1 in 28.65.

THE NEW YORK BORDER.

Capt. Patterson, Superintendent of the United States Coast Survey, has received a letter from J. V. L. Pruyn, the chairman of the New York Commission appointed

*Abstracts of Papers in Foreign Transactions and Periodicals. The Institution of Civil Engineers, London.

*The actual length of the St. Gothard Tunnel, which is not given in Signor Pacho's Paper, is 16,241 yards. The work was contracted for by M. Favre, on 7th August, 1872, at a price equivalent to £116 8s. per yard, to be completed in eight years. The last 4,781 yards of the Mont Cenis Tunnel were let to MM. Sommeiller and Grattoni at a price equivalent to £167 12s. per lineal yard. It was conjectured that the cost to the contractors did not exceed £74 per lineal yard. The preliminary estimate of the total cost of constructing the Mont Cenis Tunnel amounted to £2,600,000; which was at the rate of £194 per lineal yard. It is supposed that the actual cost amounted to £3,000,000, which is equivalent to £224 per yard; or £394,240 per mile. The cost of the Thames Tunnel was £1,127 per lineal yard.

to rerun the boundary line between the States of New York and Pennsylvania, in regard to the detail of an attache of the Coast Survey to perform the astronomical work. Several weeks ago Col. Worral, one of the Pennsylvania Commissioners, had a consultation with Capt. Patterson on the same subject, and it was this interview which led to correspondence between the Pennsylvania and New York commissioners. Capt. Patterson will promptly accede to the request of the commissioners when it is formally made, and will designate for the work one of the most skillful men of the service.

On the 12th of October, 1786, Commissioners Andrew Ellicott for Pennsylvania and James Clinton and Simeon DeWitt for New York, appointed for the purpose of running and marking a boundary line between the two States, to begin at the Delaware River on the 42d degree of north latitude, and to continue on the same parallel to the western extremity of the States, reported that they had finished 90 miles of the boundary extending from the Delaware river to the west side of the south branch of the Tioga river, and had marked the same with suitable milestones. One year later, October 29, 1787, Andrew Ellicott and Andrew Porter, Commissioners of Pennsylvania, and Abraham Hardenberg and William Morris, Commissioners of New York, reported that they had extended the line from the ninetieth milestone to Lake Erie, and that they had marked the line in a permanent manner by milestones, or posts surrounded by mounds of earth when stones could not be procured.

The observations and surveys were conducted under the directions of the eminent astrononomer and mathematician, David Rittenhouse.

The object of the resurvey authorized by the two States is to correct the line, which it is believed varies at many points from the parallel designated in the origin charter to William Penn as the limit of his proprietary possessions in the direction of the Royal Colony of New York. This, it is admitted, was not owing to lack of skill, but to the crude state of astronomical science at that time and the imperfection of the appliances used. Of late years there has been a very general resurvey of the boundary lines of the older States, and in some cases very serious errors have been discovered, and if the commissioners should finally determine to invite the Superintendent of the Coast Survey to designate one of his assistants to take direction of the surveying portion of the work, a thorough geodetic survey be made. The crudity of this branch of science a century ago will, it is believed, present a practical illustration of the difference between surveying on a plane surface and adapting the line to the curvature of the earth.

It would also be Capt. Patterson's object to gain another advantage from the opportunity offered, and that would be to measure geodetically the arc of the parallel. The expense of this portion of the work he would ask permission to defray out of the coast survey fund, and would make a continuation of the arc to the Hudson River, from which point to Cape Cod, also on the parallel of 42° north latitude, the data are now in the possession of the office. It is estimated by Capt. Patterson that an additional work of about 100 miles out of the funds of the coast survey, with the material on hand and the boundary survey, would enable him to complete an arc of parallel of 450 miles from Cape Cod to Lake Erie.—*New York Tribune.*

APPLICATION OF PHOTOGRAPHY TO TRIGONOMETRIC SURVEYING.*

Lieutenant Manzi, of the Italian army, has recently produced trigonometric surveys by the aid of the camera, which have obtained the approbation of the Ministry of War, and have been considered worthy of the support of the Topographical Institute.

If it be supposed that an observer be placed at the point of vision of a theodolite station, and that the rays of light converging from the distant points of view are intercepted and marked on a diaphragm, it is evident that the angular readings obtained to such points would be identical in their bearings with the objects themselves. The perspective indication thus obtained may be mathematically used by definition of the three following constants: (1) The horizontal line; (2) the distance from the optic centre to the diaphragm; (3) the position of the principal point of view. It is thus possible to construct a camera, geometrically arranged, with an object glass so ground as to minimise the area of observation, or to allow of the establishment of a differential equation of the curve of error. By such a camera, negative views of inaccessible ground can be faithsully taken, and the angles can be either plotted or calculated. By obtaining photographs of this description from properly connected points, intersections can be obtained, either graphically or by trigonometric calculation, in the same manner as by the use of a plane table or of a theodolite. The main obstacle which Lieutenant Manzi encountered arose from the fact that if the points of observation selected were so near as to be perfectly distinct, the triangles became very ill shaped. On the other hand, very distant points were with difficulty precisely determined. This was obviated by operating on small base lines (from 400 to 800 yards) and estimating the primary triangulation by a telemeter (like that of Nolan). The application of the photographic details to the points thus fixed was then simple. In the case of inaccessible mountain country the advantages thus to be obtained are obvious. It is also a matter of no small importance as regards military recognisance. The results obtained in the course of the present year are said to be highly satisfactory.

*Abstracts of Papers in Foreign Transactions and Periodicals. The Institution of Civil Engineers, London.

CORRESPONDENCE.

BOSTON, *May 15th, 1877.*

Editor ENGINEERING NEWS:

SIR.—One of your readers has had experience with "tar and gravel concrete" street gutters, with only 0.1 ft. available fall in 100 ft., and recommends them to Wm. Johnson, City Eng'r, of Dallas, Texas, correspondent in your paper of 12th inst., and to others similarly situated.

C. H.,
Civil Eng., (one time Supt. of Streets.)

NEW ORLEANS, *May 15th, 1877.*

Editor ENGINEERING NEWS:

SIR.—In your issue of May 5th, 1877, I notice an article and map describing and representing the "drainage of the city of New Orleans, by F. T. Hardee, City Surveyor." With all due deference to Mr. Hardee as a map copyist, permit me to inform you that the system of drainage works were in course of construction nearly three years previous to Mr. Hardee becoming City Surveyor, which was in December, 1874, and about seven months after the city purchased the dredging machinery and suspended the works. So much for the prospective drainage of New Orleans. Mr. Hardee never designed any portion of the drainage system, and during the time he administered it, followed the system as indicated upon my plans.

In the October, 1875, number of the "Sanitarian," published in New York, the same map and article appears without credit, which is due to each other in the profession, the profile from river to lake was also a matter of record in the surveyor's office when he assumed charge. Accompanying this you will find lithograph copies of drainage map, lake protection levee, and oscillations of river and lake waters, and respectfully request that you publish this communication at an early date and oblige, Yours truly,

W. H. BELL C. E.

WAUKEGAN, ILL., *May, 17th 1877.*

Editor ENGINEERING NEWS:

SIR.—I see in the last number of the NEWS, a communication from G. C., Galesburg, Ill., concerning the correct method of re-establishing a lost ¼ Section corner. He states that on the line between Sections 24 and 25, in a certain Township, the ¼ corner is lost, and that "field notes" describe the corner as being 40 chains and 70 links from the West corner, of the Section, and 39 chains and 30 links from the East corner. The two together measure 40 chains, just full, measure, (although seldom occurring on East and West lines in Government surveys.) The fair presumption is, that the field notes have been wrongly copied. The following queries arise: 1st. Are the field notes to which he refers *correct copies* of the Government Field Notes? 2nd. Or are the distances taken from, the *Government Plat*, instead of the notes? 3d. Has G. C., had access to the *running* notes of the Government Surveyor? 4th. If he has access to certified copies of both Government notes and Government plats, has he compared the two, to see if they agree. In the first place, the Government Surveyors are required to place ¼ Section corners, equi-distant between Section corners, except in the tiers of Sections along the North and West lines of Townships. Then again, there are sometimes discrepancies between the plats and written notes, in which case the written notes are the better evidence. As plats are made from the notes, the law undoubtedly is, that the Government corners must remain as set by the Government Survey, although there may have been a mistake. The question is how to ascertain the original position of a lost corner. And in doing so, the best available evidence should be used. And witness trees, or other comparatively durable objects taken as witnesses, are usually the best evidence. The careful Surveyor will use all available kinds of evidence. In my practice I find the most satisfactory evidence by digging, to ascertain if a stake has ever been driven. On hard land that has never been deeply plowed, dug or washed, the stake-hole will show. Take a spade, or any other *sharp* instrument and carefully shave the ground horizontally, and as soon as the hard soil is reached, the stake-hole will show like an auger-hole through a board. The hole will be filled with soil of different color; and of a softer texture. These hints may be of use to G. C., or some other Surveyor.

H. WHITNEY.

ACTIVE preparations are going on for the immediate commencement of the long-projected work of draining the Zuyder Zee. A dam 40 kilometres (24 miles 1540 yards) long, and 50 metres broad at its base, is to be carried across the gulf, built up to a height of half a metre above the ordinary level of high tide. Upon this pumping machines of 10,000 horse-power will be erected, capable of pumping up from the enclosed sea, and discharging on the outside of the dam, 6,500,000 cubic metres of water daily. Taking the average depth of the water at 4½ metres, it is estimated that the work of pumping will be completed in about sixteen years from its commencement. The total cost of reclamation is set down at 335,000,000 francs; but huge as this sum is, the undertaking is confidently looked upon as likely to prove a most remunerative speculation. The success of the scheme will add to the kingdom a new province of nearly 500,000 acres in extent. Judging from previous experiences in connection with the Haarlem Sea, it is reckoned that at least 176,000 hectares of the land thus won will be applicable to agricultural purposes, which, at an average value of 4,000 francs only per hectare, will richly repay the enterprise and treasure lavished on the gigantic undertaking.—*The Farmer.*

PUBLICATIONS RECEIVED.

Annual Report of the Various Officers and Standing Committees of the City of Allegheny, Pa., for 1876. From Chas. Davis, C. E.

Report of the Commissioners of the West Side Irrigation District, San Francisco, Cal., 1877. From C. H. Kluegel, C. E.

Journal Zodtchy. St. Petersburg, Russia.

Reports upon the Foundation of the Washington Monument.

The Coal Trade, A compendium of valuable information relative to coal production, etc., etc., by Frederick E. Saward, editor of the "Coal Trade Journal." New York. 1877.

The Mississippi River. A pamphlet compiled from ths "New Orleans Monthly Review for April." W. W. King. New Orleans. 1877.

From the Institution of Civil Engineers, London:

Abstracts af of Papers in Foreign Transactions and Periodicals. Session 1876-77. Part 2.

We have received from Messrs. Fauth & Co., of Washington, their new illustrated catalogue of the Astronomical and Surveying instruments manufactured by them. It contains much valuable information on the subject of instruments and is profusely and excellently illustrated. It will recommend itself to all who send for it.

The following is the contents of *Harper's Monthly* for June, most interesting as usual:

Contemporary Art in Germany—S. G. Benjamin. With Twenty Illustrations. A Dream-land City—A Poem—Mrs. Frances L. Mace. The Androscoggin Lakes—Edward Abbott, With Nineteen Illustrations. The Niebelungen Lay—Leda M. Schoonmaker. With Eight Illustrations by Fredericks. Erema; or, My Father's Sin—R. D. Blackmore. La Festa dello Statuto. A Poem—William Gibson. The Wheeler Survey in Nevada—William H. Rideing. With Eleven Illustrations. Gibraltar—George M. Towle. With Three Illustrations by amuel Colman. Moses Clymer's Business—Marc. E. Cook. With Two Illustrations. An Order for a Cameo. A Poem—Fannie R. Robinson. Bird's Nests—H. D. Minot. With Five Illustrations. The Professor's Victim. A Story—Mrs. Frank McCarthy. Popular Exposition of Some Scientific Experiments. Part IV.—Dr. John W. Draper. With Six Illustrations. A Woman-Hater. Part XII.—Charles Reade. A Tear. A Poem—Harriet Prescott Spofford. Garth. A Novel. (Concluded.)—Julian Hawthorne. Editor's Easy Chair: Editor's Literary Record: Editor's Scientific Record: Editor's Historical Record: Editor's Drawer: A Short Sermon—A comical Compliment (Illustrated).

RAILROAD NOTES.

The Lafayette, Bloomington & Munci R. R., Ill., will hereafter be known as the Lafayette, Bloomington & Mississippi R. R., and will be under the general management of General E. H. Waldron.

California has 1,853 miles of railways, of which 176 miles, or nearly one-tenth, are of the narrow gauge. The narrow gauge is especially suited to the rugged profile of much of this State, and a number of that class are under way or projected.

At a meeting of the Brooklyn Board of Aldermen on the 14th inst., permission was granted to the Brooklyn City Railroad Company to run steam cars on Third avenue, from Twenty-fifth street to Fort Hamilton. The noiseless locomotives will be placed on that line immediately.

During last winter the right of way was cleared for 20 miles northward from the present terminus at Clayton, Wis., on the North Wisconsin R. R., and work has now been begun on the grading. Contracts have been let for the first 10 miles, to be ready for the rails by Aug. 1, and considerable force is now employed.

The Toronto *Leader* of the 16th, inst., says, it has it on undoubted authority that the Grrnd Trunk and Great Western Railways have finally amalgamated. The headquarters of the Grand Trunk Company, their workshops, fitting departments, etc., will be removed from Montreal to Toronto.

It is proposed to build a branch leaving the Dorchester & Delaware, R. R., near Cambridge, Md., and running south through Lakeville to Bishop's Head, 22 miles. Dorchester County has voted $75,000, leaving about $25,000 to be raised by stock subscriptions. The branch is expected to secure some local business and a large traffic in oysters and fish.

Some steel-headed rails were laid down upon the East Bavarian railway in 1869 at places where the gradients are 1 in 100 and the curves of 14½ chains to 26 chains radius. The percentage of renewals to the close of 1872 was as follows: 1869, 0.60 per cent.; 1870, 0.00 per cent.; 1871, 2.65 per cent.; 1872, 0.00 per cent.; total, 3.25 per cent. A similar calculation applied to steel-headed rails laid down on the Bavarian State Railways shows renewals to the extent of 2.23 per cent.

It has been decided to equip the Boston, Winthrop & Point Shirley R. R. with twenty-pound per yard angle rails, bolted to substantial wooden stringers, which are placed on ordinary ties. It is claimed that these rails will prove far superior to the forty-pound per yard T rails, as they not only prevent accidents proceeding from broken rails, but make also a large saving in the cost of construction. The angle rail is said to be adapted to standard as well as narrow-gauge roads.

At the annual meeting of the Hamilton & Northwestern R. R., in Hamilton, Ont., May 1, the President reported that arrangement had been made to extend the Lake Erie Division from Jarvis to Port Dover, 10 miles, this year. The Northwestern Division was opened in February from Hamilton to Georgetown, 35 miles, and 29 miles more, from Georgetown to Barrie, are under contract to be finished this year. Work is soon to be begun between Clarksville and Glencairn.

At a meeting of the Board of Directors of the Northern Pacific Railroad Company, the Finance Committee reported adversely to placing a mortgage on the line of road now in operation on the Pacific coast. A resolution was passed requesting the stock-holders to be informed that in view of the increased and increasing business of the road, the Board was of the opinion that all the money necessary for the completion of the branch into the coal fields of Payslip valley can be had without resorting to mortgage.

A competent engineer, accompanied by a corps of assistants, left Salem, Ill., May 14, for the purpose of surveying the route of the proposed extension of the narrow gauge road from Phillips' Corners to Wingville. The original intention was to build the road from Platteville, the present terminus, through Washburn to Wingville. That plan has been abandoned, owing to the unfavorable lay of the land. A construction train will be put on the line as soon as the survey is made, and by fall the entire road will be completed. The plan of building a narrow-gauge road from Lancaster to Phillips' Corners, tapping the Galena & Southwestern Railroad at that point, is favorably talked of.

A proposal is made to lay a street-railway track of the following description in San Francisco: "The rail, it is proposed, shall be twenty inches wide at the base and three at the top, over which the car-wheels glide. The rail is hollow, and designed to inclose the large gas and water mains side by side on the base, the connections to be made from them into the upper stories of houses along the route. Over these mains another tube incloses the telegraph wires. The rail is to be supported on large posts fourteen feet high, and placed at distances of fourteen and twenty feet apart. The posts are to be secured in the sidewalks, at the curbs, and will serve as hitching posts, and, with proper connections with the water-mains, hydrants may be attached to them." We have only one suggestion to make. Another tube should be added which should combine the functions of a pneumatic-dispatch tube and a clothes-line, and when worn out can be worked up into pop-guns and spy-glass frames.—*Railway Age.*

Pacific Railway construction is to be begun at once in Manitoba, one of the contractors having been ordered to grade and lay the track on the branch line between Winnepeg and the Canadian Pacific main line, which is located some miles to the north of that town. It was announced in Parliament that the whole of the Pembina branch, which was graded a year or two ago, when it was necessary to give the Manitobans some relief in consequence of the grasshopper plague, would be completed at once, the track laid and rolling stock supplied. The terminus of the American road is as yet some fifty or sixty miles from the boundary, and there will be very little for the Canadian branch to do until a junction is effected. But the Manitobans believe that if the Canadian branch is completed, the American company will be stimulated to secure the junction, and extra traffic for their line, by building the necessary link, and the Government have acted on their representations in deciding upon their present policy in regard to the branch.

The *Engineer*, of London, gives an account of the "highest authentic instances of high railroad speed" on record. Brunel, with the Courier class of locomotive, ran thirteen miles in ten minutes, equal to seventy-eight miles an hour. Mr. P. Stirling, of the Great Northern, took, two years back, sixteen carriages fifteen miles in thirteen minutes, equal to seventy-five miles an hour. The "Great Britain," "Lord of the Isles," and "Iron Duke" broad-gauge engines on the Great Western Railway, have each run with four of five carriages from Paddington to Didcot in forty-seven and a half minutes, equal to sixty-six miles an hour. The new Midland coupled express engines, running in the usual course, have been timed sixty-eight, seventy, and seventy-two miles an hour. The 10 A. M. express on the Great Northern from Leeds has been timed, and found mile after mile at the rate of a mile in fifty-two seconds, or at sixty-nine and two-tenths miles an hour. The engines used are Mr. Sterling's outside cylinder bogie express engines, the load being ten carriages.

The sundry civil appropriation bill, passed at the last session of Congress, contains a clause appropriating $25,000 for continuing the survey of the Mississippi river and its tributaries, with a view of determining the proper method of reclaiming from overflow the alluvial lands of the Mississippi delta, and the chief of engineer corps has directed General Comstock, the officer in charge of the work, to expend this money with a view to the construction of levees, particularly in conformity with the report of the commission, consisting of General Warren, General Abbott, Captain Benyuard, of the engineer corps, and Jackson E. Sickles and ex-Governor Paul O. Hebert, civil engineers. These surveys are essential to determine the exact location, dimensions and cost of the levees. Their estimated cost is over $300,000, They will return all matters relating to the river beds, such as heights of the banks and places where caving is taking place, or otherwise, and the past changes, as far as can be made out. Level lines will be run with the greatest care, so as to determine the slopes of the water surface, and of the land and the elevation of high water marks.

At a meeting of the stockholders of the Northern Pacific R. R., held at New York, on the 9th inst., Mr. Stark, the Vice President, said the road was in excellent condition throughout, and had never been doing a better business than during the present year. Mr. C. Tower, of Philadelphia, for this board of directors, reported adversely on the proposition to put a mortgage on the western end of the road, in order to build the proposed extension from Kalama to Portland, Ore. All expenses to be incurred on the western end would be provided for without the mortgage. It was also the opinion of the board of directors that all the money needed for the completion of the branch into the coal fields of the Payallup valley can be had without resorting to a mortgage of any of the property of the company. Mr. George W. Cass, of Pittsburgh, considered the business of the company in Dakota in a more promising condition than ever before. He offered the following resolution which was adopted:

Resolved; That the stockholders deem it to be to the interest of this company to promote and secure the building of the line of R. R. from Sauk Rapids to Brainerd, a distance of about 60 miles, and approve, ratify, and confirm the action of the President and directors in subscribing 501 shares, of $100 each, being a majority of the stock of the Western Railway company, of Minnesota, understood to build said road.

2. That the directors are authorized, if necessary, to secure such construction and to lease said road when completed, at a suitable rental, such as shall cover interest on the sureties issued to construct the same.

The directors were instructed to ascertain the cost of building the Road from Bismarck west into Montana territory, and to propose a plan for providing the means for this purpose, which they will present at the next meeting of the stockholders.

FLORIDA NOTES.

A railroad about 25 miles long has just been located from Thomasville, Ga., to Monticello, Jefferson, Co., Fla., and Chief Engineer, Chas. F. Smith, says, construction is to commence at once. The R. R. from Lake Harris to Lake George in Sumter and Orange counties is all graded and the rails will be laid soon. A large traffic in oranges is expected. It is about 25 miles long

The railroad from Waldo, on the Florida R. R., to Tampa, about 160 miles, is graded the first 32 miles from Waldo to Orange Lake, Marion Co.

A railroad is chartered from Leesburg, Sumter Co., to Hickory Bluff, on Charlotte Harbor, Mannotee Co., 130 miles. A railroad is proposed from Live Oak, on the Florida, Atlantic & Gulf R. R., through Gainsville on the Florida R. R., to Leesburg, to connect with the last mentioned road about 126 miles; work was to have been begun on the railroad from Leesburg to Charlotte Harbor at once, but the Governor vetoed the bill granting certain State lands. A short-sighted act, for this State needs railroads and could better afford to have them at most any price than not to have them. The Governor did the same thing on the railroad from Sand Point, Valusia Co., Indian river to the St. John's river. This road, about nine miles long, is partially graded, the bridges built, and sleepers and timber all cut and on the line.

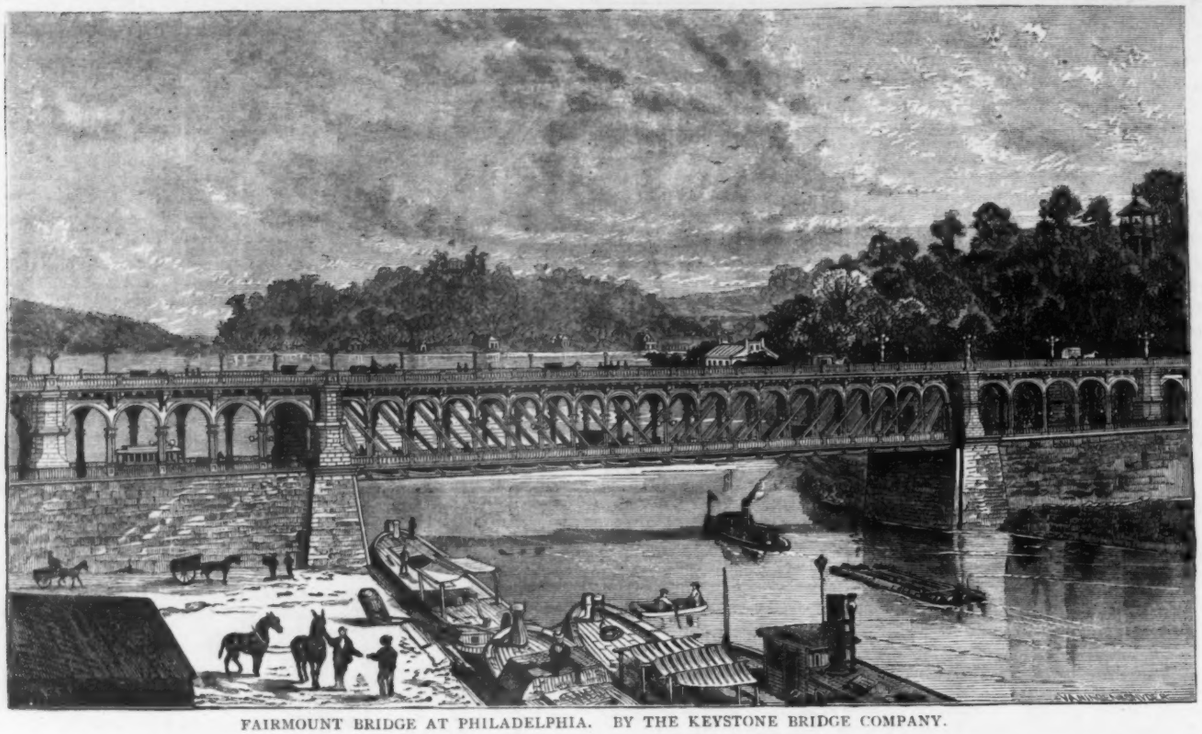
NOTES.

The Governor of New York State, has stricken out of the Supply bill the entire appropriation of $1,000,000 for a new capitol at Albany, and thirty-six other items representing an aggregate of $500,000 in addition.

The water power of Niagara Falls, known as the one-mile reservation, granted in 1806 by the State of New York to Judge and Gen. Porter, was sold at auction recently, subject to $60,000 of encumberances, to the wealthy firm of Messrs J. F. Schoellkopf & Son, of Buffalo, N. Y., for $71,000.

Justice Gilbert, of the Supreme Court, Kings county, New York, rendered a decision on the 14th inst. in the matter of the application made in behalf of A. S. Barnes and other property owners on the line of Atlantic avenue, for a permanent injunction prohibiting the Long Island Railroad Company from using steam on that thoroughfare. The case was argued about two weeks ago. The Court denies the application, with $10 costs. Work will now be pushed forward on the road.

The buildings for the Paris Exhibition of 1878 are growing rapidly. On the Champ de Mars the foundations are laid. The angle pavilions, which are of masonry and fifty feet high, are ready for the iron domes that are to cover them; and the walls of the central gallery, which is likewise of masonry, and intended for the fine arts exhibition, are almost finished. The piers of the rest of the building are ready for the superstructure of iron and glass. On the Trocadero, in spite of the great difficulty of laying the foundations on the hill undermined by quarry-galleries, the two elliptical wings are built, the substructures of the great towers are laid, and the masonry of the central rotunda is finished Two thousand men were employed upon the works; and up to the 1st of April, 1,800,000 francs had been expended upon excavation and masonry; covering 158,000 cubic metres of excavation, 30,000 cubic metres of concrete foundations and 35,000, cubic metres of masonry. Six miles of pipes and sewers had been laid.



FAIRMOUNT BRIDGE AT PHILADELPHIA. BY THE KEYSTONE BRIDGE COMPANY.

NOTES.—(*Continued.*)

The new explosive, known as "Vigorite" is formed of nitroline, nitrate of potash, chlorate of potash, and cellulose.

It is understood that a new movement is on foot to erect another bridge over the Ohio river at Louisville, from New Albany to Louisville.

Wire ropes for mines, elevators, and the transmission of power are now being made of the comparatively new alloy, phospor bronze. These ropes are said to retain their pliability after long use, and to resist the action of the corrosive waters found in mines.

A tunnel through the Pyrenees will place France and Spain in railroad communication by the 1st of January, 1878. The work has been several years in progress, and will save twelve hours of tedious diligence riding between Perpignan and Barcelona.

The City of Bridgeton, N. J., has just commenced the building of new water works. The works will be on the reservoir plan, with steam pumping machinery of not less than one million gallons per day. The water will be taken from East lake. Pipes of 16, 12, 10, 8, 6, and 4 inches diameter will be laid in all the principal streets. Isaac S. Cassin, of Philadelphia, is the engineer in the construction of the works.

The preliminary studies for boring the great tunnel of the Simplon and making accession lines are now in course of execution. The plans and measurements have been completed in the offices at Lausanne. The line commences at Brigue, which will thus become the international station, to enter the tunnel, which will have a length of 18,340 metres. The end of the tunnel will be near d'Isella, and the line proceeds from there to Bombo d'Assolla. The total length of the line will be 46,900 metres. Near Bombo it will rejoin the old works, the Italian line continuing to the station of Arona. As far as the village of Crevola the line follows the left bank of the Boveria, but crosses it there on a large viaduct.

Peru contemplates an imitation in her silver mines of the Sutro tunnel, which for many years has been in the process of construction for the drainage of the Comstock lode, in Nevada. The famous silver mines of Cerro de Pasaco, in Peru, have, since their first discovery, yielded silver estimated at $500,000,000 in value. This enormous sum was realized in spite of the unfaithful working and of crude systems that did not produce anything like the amount the ore was capable of yielding. The projected tunnel, by draining the mines, it is thought will restore their value and enable the miners to reach the richest ores. The project is the plan of Mr. Henry Meiggs, the famous American railway builder of Peru, and if it is pushed with the vigor characterizing his Peruvian railway construction, it is likely to be successful.

FAIRMOUNT BRIDGE, PHILADELPHIA.

We give above a view of Fairmount Bridge, Philadelphia. It is one of a number of similar cuts illustrating the useful work on Highway Bridges, by A. P. Boller, C. E.

We clip the following from the New Orleans Daily *Democrat*:

Col. Wrotnowski, the late Chief State Engineer, has submitted to the Governor a comprehensive and concise statement of all levee work that had been done in the State since the war, the statement showing the estimates as well as the number of cubic yards constructed in each levee, year by year, and the amount paid by the State to the Levee Company for such construction.

By that report it is shown that during the existence of the Board of State Engineers, since February 24, 1871, to date, there have been built six hundred and eighty-six levees, the total length of which is one hundred and eighty-nine miles and a quarter, which divided into cubic yards and put down to the different years, shows the following as the number of cubic yards constructed each year.

In 1871, 578,906 yards; in 1872, 2,557,761 yards; in 1873, 1,028,299 yards; in 1874, 737,952 yards; in 1875, 1,128,792 yards; in 1876, 773,193 yards; in 1877, 800,224 yards, and the amount provided for 1878, 230,248 yards, making the total bill during the existence of the Board of Engineers, seven million eight hundred and thirty-five thousand three hundred and seventy-five cubic yards—the amount set down for 1878 being, of course, approximated.

The approximate estimate for the current years shows that there are, above Red river, thirty levees, for which 2,196,000 cubic yards of earth is actually necessary, and below Red river there are ninety-two levees, for which 1,584,300 cubic yards of earth is necessary. On the Atchafalaya and Anglaise twenty-one levees require 187,800 cubic yards, and on the Lafourche five levees will require 22,000 yards; on the Ouachita three will require 52,000 yards and the fifty-eight levees on Red river will require 1,034,400 yards, this making a total of 209 levees in the State.

Col. Wrotnowski shows in his report that there have been constructed in the State since the war twenty million two hundred and sixty-two thousand seven hundred and fifty-two and thirty-nine one-hundredths cubic yards of levees at a cost of $10,972,441.47; and in his report, which is most complete, and made partly from the records gathered by himself, and principally from those made by the late Gen. M. Jeff Thompson, and giving, as it does, a complete history of the levees constructed in each parish, it would, if printed, make a valuable argument in support of Louisiana's claim for Federal aid in the construction of the levees.

CONTRACTORS' INTELLIGENCE.

The Wilson & Hughes Stone Co., of Cleveland, O., have received the contract for the entire stone work of the new Government building at Grand Rapids, Mich.

The Leighton Bridge & Iron Company, of Rochester, N. Y., are running on full time and employing about 150 hands. They are now engaged in filling a contract for six double track iron bridges for the Boston & Albany Railroad.

Morrison, Field & Co., of Buffalo, N. Y., have just received the contract for the construction of three iron bridges on the line of the Atchison, Topeka & Santa Fe R. R. The firm have also just completed two iron spans for the Missouri River, Fort Scott & Gulf Railroad.

Messrs. Clarke, Reeves & Co., of Philadelphia, have contracts for, and under construction, 40 spans, nearly a mile and a half, of iron bridges for the Quebec, Montreal, and Ottawa Railway.

The contract for supplying the rolled I beams, angle pieces, etc., for the Rock Island Arsenal, Illinois, was awarded to the Passaic Rolling Mill Company, of Paterson, N. J., and 130 Chambers St., New York City; the lowest bidders. The other principal firms who bid upon the same contract were: The Phœnix Iron Co., Phœnixville, Pa.; New Jersey Steel & Iron Co., Trenton, N. J.; and Carnegie Bros. & Co., Union Mills, Pittsburg, Pa.

For building and fixing Tank in Bellevue, Ohio:—For tank 24 feet high, 18 feet diameter, made of steel (known here as Otis steel) 3-16 in. thick for sides and ¼ in. bottom, placed in position on elevated foundation, thirty feet high; ⅝ in. rivets, hot, two inches center to center, two inch angle iron top and bottom, two coats paint, and to be made in good workmanlike manner and warranted not to leak. Buckeye Bridge Works, Miller, Jameson & Co. Proprietors, Cleveland, Ohio, was the bid accepted. It was $1368.00 for steel, and $1120.00 for iron. Lowest bid for 4-inch piping in position, 65 cts. per foot for cast iron and 50 cts. per ft. for wrought iron.

Bids accepted for erection of the Childrens' Home in Clark county, O.:—Petticrew & Bros., Springfield, O. Excavation, $280; Petticrew & Bros., Mason Work, $1,290; Russell & Sons, Springfield, Cut Stone Work, $1,035; Bryce & Webber, Dayton, O., Asbestine Stone Work, (award suspended), $1060; S. V. Boren, Dayton, Brickwork, $5,000; Geo. W. Cooper, Springfield, O., Lathing and Plastering, $993; Arbogast & Penfield, Springfield, Carpenter and Joiner Work, $5,688; Ackerson & Bros., Springfield, Slating, $425; T. B. Peet & Co., Springfield, Galvanized Iron Work, $1,108.80; T. B. Peet & Co., Tin Work, $325; Slevin & Hale, Dayton, Painting, Glass and Glazing, $831.38; Graham Jardine, Springfield, Plumbing, $899.86; Brooks & Kemper, Dayton, Steam Heating, $1,897. Total $20,833.04.

For the Excavation in the Harbor of Baltimore, Md.; J. H. Fenner, Albany, N. Y., 90,000 cu, yds. at 10½ c.: 160,000 cu. yds. at 12 c. M. F. Brainard, Albany, N. Y., 90,000 yds. at 10½ c.; 160,000 yds. at 12 c. G. C. Fobes & Co., Portland, Me., 400,000 yds. at 10¼ c.; 450,000 yds. at 12 c.; 250,000 yds. at 15 c.—on their own dump. American Dredging Co., Philadelphia, Pa., 90,000 yds. at 14 c.; 160,000 yds. at 11½ c. G. H. Ferris, Brooklyn, N. Y., 250,000 yds. at 10⅜ c. Morris & Cummings Co., New York, 850,000 yds. at 11 c.—on their own dump. Atlantic Dredging Co., New York., 150,000 yds. at 11½ c.; 250,000 yds. at 10¾ c.; 400,000 yds. at 10½ c.; D. Constantine, Baltimore, Md., 160,000 yds. at 9¾ c.; 90,000 yds. at 9⅞ c. 400,000 yds. were awarded to G. C. Fobes & Co., at 10¼ c., to be put on their own dump; 450,000 yds. awarded to the Morris & Cumings Co., at 11 c., to be put on their own dump; 250,000 yds. awarded to D. Constantine, at 9¾ and 9⅞ c., to be put on City dump. Dumping ground costs from ½ to ⅝ c. per yard, so that a bid of 10-c. material to be put on a place provided by contractor, is equivalent to one of 9½ c. when the city has to furnish place of deposit.

COMMITTEE REPORT OF THE OHIO ASSEMBLY ON THE ASHTABULA BRIDGE.

It is perhaps fortunate for Mr. J. M. Goodwin of Cleveland, that he did not carry out his intention of publishing a book on the Ashtabula Bridge disaster, for the report of the joint committee of the Ohio General Assembly, recently printed, is so full and satisfactory that it would have materially interfered with the sales of such a book. Through the kindness of Mr. Geo. S. Converse, a member of the committee on the part of the House, we have been favored with a copy of this report. It is very full, comprising in some 160 pages, the evidence of Messrs. Tomlinson, Rogers, Congdon, Stone, Collins, and Folsom, the expert testimony and reports of Messrs. Crehore, Gottlieb, Becker, Williams, and Howland, besides the report of the three engineers from Columbus, O., appointed to examine and measure the bridge. There accompany the pamphlet, strain sheets, templets of the I beams, plan, elevation, and very full details of the structure, and a sketch showing how the braces were chipped away at their ends. Those of our profession who continue to feel an interest in this matter, and who desire to possess this amount of information in a convenient form for reference, will find much that is valuable in the pages of the report.

The pamphlet also contains the draft of a bill "to secure greater safety for Public Travel over Bridges," which introduces very stringent requirements as to load, maximum allowable stress on the square inch, and inspection. In reading this bill we are strongly reminded of the reports of the committee of the *American Society of Civil Engineers* on the "Means of Averting Bridge Accidents;" we should not be surprised if those reports and the discussion which followed were referred to by the framers of this bill. As there is so much of interest to engineers in this bill, and as an abridgement would be nearly as long as the original, unless we left out some noteworthy features, we give it in full in another column.

MONTREAL MAIN DRAINAGE.

The city of Montreal is exercised about its drainage, and a scheme having been designed and work upon it already considerably progressed, it has been made the subject of much heated discussion in the city council and quite recently two reports have been made by Mr. Ansley the city surveyor, and at present the work has come to a stand still to await an examination and report by an outside Engineer. We quote from Mr. Ansley's reports April 11th and May 10th the following general remarks on the subject of city drainage.

Cities grow to considerable size before there is much attention directed to the subject of draining. Drains and sewers are constructed by proprietors, and afterwards by the Corporation, without any general system. In fact, it is a matter of growth and not of design. After a very large amount has been thus expended, an engineer is called upon to design new works that shall fit in with a great deal of what exists and which may be utilized, at the same time reconstructing what is too defective as to material, size or grade.

A plan may be prepared of the drainage of a whole city on the most perfect engineering principles, which, if carried out at all points, would be an admirable work; but the large amount already invested forbids the breaking up of every sewer to make another in conformity with such a plan.

The drainage of a city practically is first a patchwork, followed afterwards by a series of new works by way of amendment.

Mr. Ansley in his second report describes the topography of that portion of the city traversed by Craig street, along which it is proposed to lead the main drainage from the adjoining higher grounds by means of what is termed the Craig street Tunnel. He further remarks:

In the gradual building of a city, the inhabitants follow the natural drainage as their guide, seeking lower grounds from any point when they are building; hence, the sewers in this city were carried simply downwards, without any thought as to the difficulty of getting rid of the waters after it had been thrown into the valleys.

Some 30 or 40 years ago, so far as I can gather, a difficulty arose as to how to get rid of the water from the valley of Craig street, and then, for the first time, engineering skill was called to their aid by the people or City Council.

The system of natural drainage has sufficed heretofore, but now artificial drainage was needed, and, in view of the conditions existing, the design adopted was sound in principle. Craig street being a long line with slight grade from east to west, and for about half the distance practically a dead level, the length between Papineau and Victoria squares as divided into two parts, east and west of Lacroix street, and in each of these divisions there was made an artificial summit, so that there were, really, four sections, each having its own descent.

To fulfill this design, it was absolutely necessary to tunnel through the ridge under St. Mary street, and so make a new outlet to the river. This was formidable work at that time, but it was done. Now came also, in this connection, the era of brick sewers, although wooden ones were not abolished.

The sewers descending east and west from St. Lawrence street were of brick; those descending east and west from Panet street were of wood. Had these works been as well executed as they were designed in principle, it is probable that the present Craig street tunnel would not have been entertained. But later on two distinct causes arose inducing a change; the sewers in Craig street were not satisfactory; the tunnel under St. Mary street was very defective; to the east, the wooden sewers were at too slight a depth below the surface, too small, and with grades that allowed sediment to lie permanently on their flat bottoms. All these defects might have been overcome by reconstruction, but yet a more formidable objection existed. The public and the Council were strongly opposed to the issue of sewage into the harbor at Lacroix and McGill streets, and unless these issues were permitted, the whole design of Craig street had to be abandoned and undone.

Public opinion went further—it pointed out that the outlet should be at least as low down as the Current Ste. Mary, and the engineer's task became then, not to devise or defend the best method of drainage, but to accomplish an object under certain restrictions.

We have no long catch-water drains, as sewers running from west to east. The drainage of the hills is by sewers running down, like St. Lawrence and Bleury streets, while the long lines, like Dorchester and Lagauchetiere streets, are cut into feeders for the steep drains. The bulk of the water is let down on to the low grounds, and in view of the objection to letting it into the harbor in front of the city, hence the design of the present Craig street tunnel, the result of what has occurred before, and of the conditions that exist.

The tunnel will relieve the valley, and will also relieve the sewers which flow into it, and will be found practically efficient. There will be sediment of road grit in it, or any other insoluble matter which gets in, but this is common to all sewers. Its shape is particularly adapted for economical cleansing. The theories of sanitary engineers usually point out that all sewers should be self-cleansing, but it is well known that this very seldom, if ever, obtains in actual practice, When important works of main sewerage are entertained by a community, the general scheme should be prepared by their engineer and submitted for their discussion and approval; they should then, before finally deciding on the merits of the scheme, call to their aid the opinion of some outside authority in sanitary engineering works, after which the general principles should be adhered to, and the details carried out at that basis from time to time as required.

The most of the latter document is necessarily local in its character, but is throughout a clear presentation of the causes which led to the adoption of the scheme of drainage in controversy. The principal opponent of the scheme is Alderman Gauthier, and the following description of the meeting of the Road Committee during the reading of Mr. Ansley's report, indicates that the French element was characteristically lively.

We quote from the *Gazette* of May 10th:—

The report was read during a cross-fire of conversation, and little of the attention paid to it that is due a paper dealing with a subject of such importance, and coming from the engineer in whose charge the interests of the city's drainage are supposed to rest.

During the confusion of words that ensued the representative of the *Star* casually mentioned that he had had opinions against the Craig street tunnel from Messrs. Shanley and Hannaford, the well known engineers, and an opinion partially against it from Mr. Kennedy.

City Surveyor Ansley expressed his surprise at this, and said these opinions could not be officially given, as he did not think the gentlemen would give opinions on such a subject in a moment.

The *Star* representative said he had the opinions in writing, but had never used the names of the parties although the matter had been published.

The City Surveyor said if it was the wish of the city now to stop the work on the tunnel and procure the assistance of an outside engineer as to the merits of the case, no better authority in sanitary drainage could be found than Mr. Chesbrough, Chief Engineer of Chicago.

After some further conversation, a motion was carried to report to Council to stop the tunnel at Lacroix street, and to invite Mr. Chesbrough of Chicago, together with a resident engineer, to look into the whole matter of the Craig street tunnel; also, that Mr. Ansley be instructed to write to Mr. Chesbrough as to the arrangements.

After passing some other matters of routine the Road Committee adjourned.

THE ease with which photographs can be taken, and the moderate cost at which small views like those for stereoscopes can be obtained, enable one to possess pictures of important works in various stages of their growth. They of course show the false works, with the various appliances and expedients used in the construction, and, if well selected, enable one to readily understand the design. They are, in some respects, superior to drawings, unless dimensions are desired, and serve also as a very handy record of progress at different dates. The stereoscopic views of the arches over Charles River at Newton, Upper Falls, on the Sudbury river conduit of the Boston Water Works, are excellent examples of this sort, and will repay careful inspection.

THE Coroner's jury in the Rockford Court House disaster rendered their verdict on the 23d inst. After reciting the circumstances of the accident they give as the cause of the same—

1. The neglect of Henry L. Gay, the architect of the said building, to provide for the great amount of weight called for to complete the construction of said building according to plans as designed by him.

2. The want of care or prudence on the part of said architect in not giving special specifications and plans for the part or parts of the general plan required or expected to carry the weight in proportion to their superfices.

3. The fact that the Board of Supervisors failed to use that caution in examining the plans and specifications that the construction of a building of that magnitude would seem to require, and that they acted unwisely in not employing a competent architect to superintend the construction of the same.

CHICAGO at present presents but a poor field for sewer contractors and sanitary engineers. In view of the continued impecunious condition of the city treasury, the Finance Committee at the meeting of Council, May 14th, recommended that the sum of $79,000 only be borrowed for the purpose of completing the sewers already under contract. It is probable that this recommendation will prevail.

THE position which late developments in connection with the New York City, Rockford and Chicago Court Houses, proves the architects of these important structures to hold, is not very flattering to the profession. In these cases the architect appears to be but a draughtsman, useful only to make plans, tracings or such drawings as the contractor may want; he is nominally the source from which all instructions proceed, but really he cuts but a very small figure indeed, except to shoulder all the responsibility of mistakes and disasters. Gay sold some plans to the Rockford Committee, and that is about all he has had to do with the ill-fated structure which he designed, until called upon to protect himself against the possible charge of manslaughter; the daily press of this city is full of charges of "crookedness" against everybody connected with the new court house, and according to all accounts, architect Egan plays a very small "second fiddle" in its erection. The Chicago *Tribune*, referring to certain departures from the specifications, remarks:

It may appear surprising that Architect Egan, who has charge of the building, should allow any deviation from the plans he drew and the specifications he framed. But the trouble is that the County Board elected a Superintendent by the name of Handley; and, while he is nominally Mr. Egan's subordinate, he is practically his equal or superior. Mr. Egan has served upon Handley reams of notices and directions. Some of them Handley has observed; others he has disregarded, following only such as jumped with his peculiar notions. The unfortunate feature of this is that, while the responsibility is really divided, Egan will, if anything happens, be held responsible for whatever mishap there may be; and it would appear to be the wisest thing for him to either claim the control which belongs to him, or wash his hands entirely of the whole matter.

An architect is allowed to appear important and to give a great many directions during the occasional ten minutes' visits he may make to a city dwelling-house or warehouse in course of erection under his "superintendence," but after all his functions prove to be merely those of a draughtsman, and only too often they are about all he ought to have.

PERSONAL.

Among other changes in the faculty of the School of Mines, Columbia College, New York, is the appointment of PROF. WM. P. TROWBRIDGE, lately of the Sheffield Scientific School, Yale College, to be Professor of Engineering. The school is fortunate in securing so ex-

perienced an occupant of this important chair. He was born in Troy, Oakland county, Michigan, in 1828, graduated from West Point in 1848 with the highest rank, having assisted during the last year of his course in instruction in chemistry; and, for some years after, he served with much efficiency in the Coast Survey. He resigned in 1856 to accept the professorship of mathematics in the University of Michigan, but, within the year, at the request of PROF. BACHE, accepted a permanent appointment in the Coast Survey. During the war he did good service as a military engineer. At its close he became superintendent of the Novelty Iron Works, in New York city, where he remained until 1870, when he accepted the position of professor of dynamical engineering in the Sheffield Scientific School.

GENERAL C. B. COMSTOCK of the Engineer corps, has been granted leave of absence for one year with permission to visit Europe. It is understood that he will, if permitted by the belligerent governments, to visit the seat of war in the East.

ARTISTIC ENGINEERING.

BY HENRI J. HABER, M.S.C.E.

Engineering, restricted to its modern signification can not be traced farther back than about a century, previous to which time it formed no distinct science. The mason or carpenter built the bridge in which were embodied only material necessities; important works as those for water, and fine stone bridges were constructed by the well informed architect. We know and it is easily exemplified, that art is old, as old as man; not so engineering. We can define the latter as the art or science of constructions; it would follow then that engineering is dependent on art, but confining ourselves to our subject, we maintain that art is, in a measure dependent on engineering; we need only mention the printing press to illustrate, or the simple steam engine and note the great advantages accrued to art by them.

But returing again to the position of art assuming the foremost rank, we see, that in nearly all the older engineering works, art is given a most prominent position, and the science of engineering is but little heeded; we need only point to the highly ornamented bridges of Frankfort and Heidelberg, and note their scientific errors, nevertheless they are very much admired—simply for their art.

Engineering as observed above became a distinct science about one hundred years ago, and since then how has it been developed, and what engineers are there now? We can enumerate the civil, military, mining, mechanical, and many others, who claim the title, so that to become an engineer in the fullest sense of the word, one would have to be an universal genius. It is not our intention in this treatise, to speak of the general term engineering, but in connection with art, to consider civil engineering, or that branch which has solely to do with building of roads, railroads, waterworks, bridges and other public works. The term civil may properly include other branches, but for the sake of simplicity we will take it referring to the subjects above mentioned. The origin of this branch as a distinct science dates back to the development of the mathematical and natural sciences, and by the application of these the engineer has raised his branch to a science, making less use of the empirical. What greatly aids the work of the engineer to-day is, the methodical arrangement of past experience and observations. But observe now! Since the introduction of the scientific element into this branch, it will be readily conceded that there has been a gradual dropping out and off, as it were, of all artistic elements. It can be easily seen that the engineering of to-day in its so highly scientific development, has but little to do with art, so also in books on the subject do we find but little reference to art.

It is true that engineering does sometimes impair the beauty of a scene; as for instance, the deep cutting of a roadway impairing the harmony of a landscape, or the straight line of a corrected river impairing the picturesqueness of the meandering stream. But take works above the ground, consider bridges, aqueducts, retaining walls, etc., how can these be rendered less hurtful to the refined feelings of the truly artistic engineer?

Before proceeding further, it might be well to say a few words concerning architecture, that is— "artistic construction, or graceful and decorated buildings." For a purely architectural work "grace embodied in structural contrivance and grace superadded" are necessary. It is obvious then that the work of the engineer should be equally with that of the architect, "the legitimate subject of graceful design, that is, art."

There should be no distinction between the engineer and the architect, save that arising from the convenience of a division of labor, the engineer confining himself to bridges, railroad constructions, etc., and the architect to buildings. We were careful in the foregoing to leave out of consideration all but the works of the *civil engineer*, for these only stand in close proximity to those of the architect. It is not necessary, nor is it desirable that there be steam engines in the different orders of architecture; but bridges and other such works can, and should be, for by attaching columns, entablatures, and other parts, we can render to the bridge, or any particular work of the engineer, any certain architectural style.

Let us now look to the opposition brought up against art in engineering: we have before us, the utilitarian, the empty pocket, and the art aristocrat. The utilitarian declares art is a luxury, and objectless; he has nothing in view save the immediate end of the work, and judges it accordingly. Now the reason for viewing the matter in this light is purely subjective, as necessarily the sense of understanding art is defective in the utilitarian. The harmonious working together of thoughts and feelings is necessary for a perfect comprehension of an object of art, which is only produced through the united action of hand, head, and heart. The utilitarian's view is certainly caused by the tendency of the times; a peculiar practical age are we enjoying, that is, we as a people have not about us that dreamy sentimentality of the theoretic German institutions, whence, it will be acknowledged, if art is to take a position in engineering, it must proceed.

It is true we see happy efforts to give to objects of handiwork an artistic appearance; we do well to imitate the common household articles of the ancients of a purely classical period. At present we are first technical, then, and only then, are we artistic; the age we say is a technical one; even in the fine arts, technical skill is more observed: we say of a painting, the effect of light or shade is good, the colors are well contrasted or blended, technical skill; so also in music, before we trouble ourselves with the depth of feeling or thought expressed. In this position are we at present, but are we to remain here? Are we not continually striving to rise higher in the scale of humanity? Are we not continually striving to widen the gap separating us from our Darwinian ancestor? The ape is a utilitarian, he builds or seeks himself protection from the raging storm, simply because of material necessity caused perhaps by some innate feeling. The first step in civilizatton is to satisfy our wants, and this in a most practical manner; this accomplished the mind seeks to improve itself, something higher is sought than simply to live, we wish to satisfy other than mere material necessities. Looking at many objects around us, from a utilitarian standpoint, how useless they appear. How senseless it seems to weight oneself down with trinkets. Fortunately, however, the refinement of civilization finds other expression than in requiring all objects to be absolutely useful. No utilitarian should have any sway in our state of civilization; he should be treated with contempt, or rather pity.

There is also an aristocracy of architects, who hold that art in engineering is out of place; this aristocracy maintain that a church is more than a palace, and thus better than a common dwelling-house, but the works of the engineer are placed by this class far below all these. We engineers should build the bridge so that his architectural highness should not wet his feet in crossing the river, that he undergoes no danger by a breakage, that the bridge be built therefore strong enough. We hold that there should be no degrees of beauty in buildings; a common Swiss cottage may be far more beautiful than a marble palace. It is not intended if art be applied to engineering, that a spiritual idea is to be expressed, even if there be manifold ideas connected with many works of the engineer. For example, if a bridge were to be represented over which Ceasar could have crossed the Rubicon, it would certainly have a different appearance than that on which Horatius kept at bay a whole army. No! the art aristocrat need have no fears of us encroaching on his domain, if he wishes to keep engineering and architecture as distinct branches.

Perhaps the chief opponent to art in engineering is the cost. First comes the fulfillment of object; then art is assigned a small place, if any; it comes late, much has been already expended on the former object, and but little is left for the latter. The cost can be effected by the strictest economy of parts of construction, and also by necessary parts and forms tending to ornament. In relation to the first: the strictest economy must admit of some freedom, as in the preparation of the material, in painting, the cost of yellow, red or green paint will be perhaps the same; the expense will not vary much if ashlar be hewn in square or oblong blocks. In building a bridge, much freedom is left the engineer, as to span, dimension of piers, etc., then why should not this freedom be devoted to an artistic choice, as luckily taste costs nothing. It is too material to allow of none but purely necessary parts to be brought into the structure; we should look to the effect of ornamentation in public works, which surely affect private dwellings. See the harmony in some of the older European towns, Nuremberg, Rouen, even affecting modern improvements. Why should we then not devote a little more of that all powerful agent, that is to say if possible, for "absque argento, omnia vana," to ornamenting, so that a good effect can have a result, not only on surrounding buildings, but also in the enlightenment of the people.

To devote a short space to art. What is art? We can say, it is caused by certain feelings in man which are expressed in some forms, and art in these is a perfect harmony between these feelings and the expressed form, which created by the artist should be understood by the observer. It is not necessary to our being that art is called forth, necessity does not call for art, the cry of the hungered is not for art, although peculiarly sensitive feelings are experienced. Common material necessity will not produce art; it is the feeling and understanding which causes its production, and only those possessing these can enjoy an object of art. Understanding without feeling cannot comprehend a work of art, neither can feeling alone; it is only the combined action of these that can give a just criticism on a work of art. For a comprehension of such there must be a corresponding idea in our mind, and a capability of judging, of comparing the object before us, and our idea; it is this which must be cultivated in the people, in order that if a work be really artistic it can be understood, thus raising man above the level of savagery.

The being of the art of building has its origin in merely natural necestities. Architecture is considered a fine art, and the fine arts call for spiritual investigation; how are we then to unite art with building so that an object of feeling and understanding be produced, at the same time all material, natural necessities being fully satisfied? We have nothing to answer from, but the limited space and the material employed. But is it at all possible to find anything spiritual in these? Yes! if both the space and material be in a manner idealized. Without going too deep into the discussion, we can say that certain spiritual relations can be regarded before the space be determined, the people for whom the work is constructed, the surrounding locality, etc. As to the idealization of material, of inorganic matter, there are certain laws which present themselves for consideration, such as those of gravity and strength, the destroying influence of time and weather, and the architect depending on these will produce a work approximating more closely to nature. By adhering to these laws, we must adopt certain forms and dimensions, certain properties of symmetry and harmony—these conditions the work must have in order to be judged artistic, and in such a degree that the observer can immediately see the arrangement according to nature.

The idealization of the object of building does not always produce a work of art; the tomb enclosing the remains of some aboriginal chief was built by his faithful subjects as a great high mound to show his greatness; the ethical determination of the work has in this case been idealized, but no object of art has been produced, any more than representing Charity as a boy untying a tin kettle from a dog's tail, even though the form of the boy be faultless, the dog perfection and the kettle marvellous in its representation. In the temple we have undoubtedly the first real object of art in architecture, wherein both object and construction have been idealized.

We see now what there is to be considered in this treatise, and will proceed, dividing the subject into the

following themes, which shall each be discussed in brief, viz.: The object of the work, the laws of strength and gravity, ornamentation, color, landscape, harmony, and style, of course all being applied to engineering.

The purely technical use of an object, if formed accordingly, will not render it beautiful, but should it not be conformable to the idea of construction the object becomes in a sense ugly. For instance, the technical use of a bridge requires that there be easy communication between both ends, that the river be not blocked; we can readily conceive the impression the work would make upon us were these requisites in any way disregarded. In engineering little is done to extend a work beyond merely material satisfaction, whereas in architecture a union of material necessity and certain ideas of art or beauty are almost inevitably observed. Why then should this not be the case in engineering? A common urn of to-day is a national necessity, so also were those of the Grecians 2,000 years ago—ours is a necessity, theirs, also, but with art.

We give our opinion expressive of the beauty of an object in nature, by certain impressions it makes upon us, by analogy to certain ideas of beauty in our minds: tenderness, sublimity, slenderness, or boldness, so also are we to judge of engineering works, to observe their conformity to nature. We can see now that the object and construction of the work are connected. Two drawings should be made, the first giving the technical design, the second, the same with certain immaterial changes and additions, which would render the work an object of real art. Great care should be taken that in ornamenting any work the limits be not overstepped, that the strict purpose be adhered to. How often do we see buildings which are absolutely ridiculous, or really hurt our feelings; imagine a warehouse in the form of a Grecian temple or a narrow foot-bridge built as a Roman aqueduct. In the garden of the Villa Palavicini, near Genoa, is a building the front of which is in heavy massive stone, the rear is light pretty Swiss cottage architecture. In these examples certain effects are produced, but little art.

In rendering a work pleasing monotony should be avoided, as in long lines of arches, which can be easily remedied. One of the greatest secrets of pleasing and proper architecture is correct proportion; how easily does the proportion of the height to breadth of a rectangular opening effect the most uninterested. Of this property of art, if we may call it such, we know no reason; the knowledge of correct proportion is inborn; there can be no other account given of it. Then we have symmetry, which in nature a law, should also in engineering be a law; we have symmetry of lines and of masses, the former requires exact symmetry on both sides of a dividing line, the latter only a symmetry of mass. By adhering to these laws impressions of dignity, clearness, and boldness result; if any spiritual idea be connected with a bridge it should certainly be clothed with these qualities. Of course, no rule without exception, even from the laws of symmetry there can be turnouts, without in any way disfiguring beauty; how picturesque are some of the Italian country palaces, with their combinations of high and low, wide and narrow parts, additions and extensions, how different all this to our modern dwelling house; perhaps this can not apply to engineering, but why not? If the necessary conditions allow a work to be unsymmetrical, positively nothing can be brought up in opposition. The relation between various parts of a structure should also be considered; in a trussed girder if its height be greater than the passing locomotive, the girder appears heavy, give it the opposite proportion, and it will certainly look lighter and more ornamental. Very little can be said concerning proper proportion which is ruled by laws, of which we know very little, but we ought to be ruled by good taste, which after all can alone produce elegant proportion.

In speaking of the object of the work, the relation in which the people stand to art, should be considered. There is not now that happy condition in which the ancients lived. No! the artist stood then as one of the people, the invention and production of a work of art went hand in hand, then was there no rank between the artist and artisan; then was there no critic save the people. At present we are in a different state, we are divided into the people and the artist, the former knowing but little of the doings of the latter. Happy are we to note that this state is being improved upon, the people are being awakened to a higher sphere of education rendering them somewhat more appreciative of real art; the time must and will come when we shall have higher thoughts than the mere fulfillment of material desires, the time must come when lectures on art will be delivered more universally to attentive students at our Polytechnic and other institutions of learning. The engineer should certainly make some allowance for the ignorance of the people in his artistic developments; what he builds is not for a selected few but for the community. The people should know the ornaments which are chosen; instead of the lotus and fig-leaf, why not the rose and ivy? the people know these and certainly greater asthetical effect would be produced by these, than by the representation of hot-house plants of which the people have no idea. If there are to be statues to adorn the bridge, choose known heroes, or men of note, not mythical or mythological figures. On the bridge at Heidelberg, Germany, is the statue of some prince, opposite to which is a Minerva; the people in their ignorance have christened her the prince's wife. What there is necessary is the proper cultivation, and having this the engineer need have no compunction as to the effect art will produce.

A theoretical study of the strength of materials will give to the engineer the proper form and dimension in construction, so that with the least possible material the greatest strength may be obtained. He cannot, however, carry out his calculations to the full letter; for instance, a beam requires theoretically to have the largest proportion of height to breadth at its middle point to diminish to naught at its ends. Not alone is the theory partially disregarded because of technical difficulty or impossibility, but also because of—art. The arch has generally a circular form, the one deviating mostly from the curve of the middle line of pressure; it is only æsthetical influence which causes this, as certainly the arch can be just as easily constructed in one form as another. We see in this the opposition between statics and æsthetics; which should have the supremacy? We answer neither: "the union of art of building with the laws of strength and gravity should be raised to an esthetical motive," in as much as an artistic inspiration introduces into laws (it matters not which) poetical impressions and deeper feelings; naturally such an ideal comprehension should not act as a destroyer of laws. The simple execution of statical laws causes a certain regularity of the whole work, but the mere fact that there will be no downfall of the structure does not call any very sensitive feelings into activity; however, if at the same time a certain life be given to the work, and we see a lightness and gracefulness about it, we say it is beautiful. The necessary technical laws are satisfied in simple construction, when there exists the required perfect equilibrium of all the forces acting; by art, the work receives, as it were, a coating or covering, which certainly will not effect its stability. In adorning a work strict regard should be paid to that part constructed on purely scientific bases, and the ornamentation should have a certain analogy, and in so doing a perfect harmony will be obtained, and neither the highly scientific engineer nor artful architect can feel slighted.

In ornamentation we have before us a field vastly extensive. It is a general impression that all those parts which do not strictly belong to the construction are simply ornamental; this idea is, however, erroneous, for who can tell where necessity ends and superfluity commences. In a very strict sense, all ornamentation is unnecessary,—a rough oblong block of stone will serve as a column as well, perhaps better, than the delicate Corinthian; but having advanced so far in culture and art, we say emphatically, the column must be rounded, it must have certain proportion of diameter of shaft to height, it must have capital and base—in short, it must be ornamental. We will not better the work by ornamentation any more than to render it more attractive; how cold and bare would the different parts in architecture appear denuded of all ornamentation, as in the framing of openings, and profiles of mouldings. To the artistic eye must this not be a glaring defect in Engineering? Decoration is not simply an annexed ornament but a completion of a work of art.

To describe suitable ornaments for various works in engineering we would have to pass beyond our province; but before taking up another topic we will offer a few suggestions, which might prove beneficial to ornamental engineering. As to quality, always a proper application and always the analogy are to be considered. The quantity should be regulated and care should be taken that the work be not too ornamental (sad sarcasm in engineering) as in the Gothic building on which every space is ornamented. As to the size of the ornaments are we also to pay attention; a small space with large ornaments is as false as a large space with small ornaments; this perhaps is all important, and a really artistic thought is requisite to render a work in any way perfect in this respect.

One of the first æsthetical impressions which each and every earthly object has upon us is its color; its effect is even more immediate than that of form; children, and even animals are affected by it, so that this topic, which although the least understood, requires the most thought. The educated mind will overlook many an imperfection, if the color be pleasing; monotonous scenery if illuminated appears grand. As above said, of all means of art, color, although so important and powerful are its effects, is the most difficult to comprehend; we can not define it, we can compare it, yes! as with temperature, a warm or cold tone, or with weight, a light or heavy shade. If the sense for color be the least active, it can be immediately seen whether colors harmonize, and in this fact lies nearly all that can be said on this subject. We dare not commence any physiological discussion on color. But to our subject: the color of the works of the engineer. What we should ever remember is the simple axiom, that color and form should agree in the artistic effect of a work. Color stands in about the same relation to building as ornamentation does, and should therefore be applied with similar restrictions. If different coloring is to be applied to a work, to give a heavy color to parts bearing heavy loads, and a light one to auxiliary parts, would be in a measure an artful reasoning for coloring. Color can be used to render a work lighter or heavier; a bridge may seem very pretty on a draughting board, but seen in reality, in perspective, it might appear heavy or clumsy; a covering of light paint might remedy this evil. There should be a perfect agreement between the effect of color on a work and its general charisteristics, hence the number of colors and the result of combination should be observed. Too many colors may destroy the impressions of repose, earnestness, and dignity belonging purely to works of engineering; perhaps pretty contrasting colors may be used with pleasing effect, for instance, on the railing of a bridge, as this has but little to do with the structure. Color is employed as a protective medium, as well as for decoration; naturally in practice these are combined. We can not, however, always use that color which would be artistically correct, the climate perhaps would be the first preventative, as above all, durability is required; the polychrome of the east remains long perfect after the simple coatings have been effaced by the weather in our land. In coloring a work it would be well to consider whether the material to be painted, or the coloring matter itself be more durable; in architecture this need not be discussed, but in engineering where works are subjected to the dampness of the earth, or in bridges, the vibrations caused by the passing trains; this is a point well worth the consideration.

We might tender some few suggestions which if observed might give to engineering more real art than it has hitherto been blessed with. Coatings of paint are proper where the building material requires it to increase its durability; the paint should not cover the original statical design, should not be applied so that the form be altered, but particularly no architectural part or form should be painted in imitation. Color has been employed to assist in finishing the form; a simple line of shadow might improve a moulding, but we can favor of no deception; this is too tricky and does not show a proper feeling for real art, we would not have

> "Rich windows, that give no light
> Nor 'ways' that block the 'road.'"

In considering the character of landscape, and its effect on works of engineering, we enter into conflict with nature and must needs tread carefully; if we study the different moments we will find some true harmony between the work and the landscape. Nature should be altered as little as possiale, the work should close on to the original form of the ground, open rock should be built upon, trees and water courses should be spared. How picturesque is a village built on a rocky mountain

side! The engineer thinks little of this, he has to remove the unevenness of the ground, etc., in fact to destroy nature. If you would render a bridge harmonious with surrounding scenery, the cost prevents, almost inevitably; take, for example, a light truss work or suspension bridge in some sublime Swiss landscape, where instead of this, one in massive stone with towering proportions would be the more proper. It is true that contrasts are also very pleasing, but then harmony is lacking.

Decoration often lends harmony to landscape, the impressions of rich or poor country, wild or mild, can be easily represented in the work. Proper choice of color can have good effect on this harmony; generally, contrasting colors are used, if the scenery be particularly green, a red tone can be given. What best harmonizes in every landscape is the old, grey, moss-covered stonework; this we must not allow to go too far, as the original idea might be lost and the work become a ruin.

The next and last, perhaps the most important question to be answered is, *In what style are we to build?* As regards periods and styles in architecture, we are now in a state of active fermentation; some maintain that only a few improvements are necessary to the already established relations; others wish for a new style with certain similarities to the ancient; still others who would do away with all existing styles, but can offer none in their place. We see now how impossible it is to answer the above question. Without any general culture as in the classical period, there can be no general style. It is the problem for the art critic to solve, he has to prove all and retain the best, and then he is to unite this sifted material with a certain spirit free from all mechanical ideas, with a spirit of pure feeling; with this something new can be developed. Let us hope that the new style will be "after the progressive idea, and not the archeological." No matter what it may be, Greek or Roman, a return to the mediæval art, or Romanesque, or a new Renaissance, whatever it may be, it will depend on the architect, whether it is to be "one in the right direction, a long-lived or a fleeting one." We cannot enter here into any discussion concerning what peculiar style can arise from such a combination; in all probability nothing absolutely new can be created; only from the now existing and known styles can a new one be evolved that is in an eclective combination of all. And so must this important question be laid aside; we would answer, build in the best if none can be created. Should we in our advancement ascend to such a state of pure art as was shown in ancient Greece would there then be no necessity of asking the question, in what style are we to build? It is true we might enter into a detailed description of the various existing styles and their applicability to engineering works, but we would then be overstepping our province, as it must be understood that the same reasoning is to be applied to engineering as to architecture.

With this we have come to the conclusion of our subject; it has been a general one, and very geuerally has it been treated. We could not however afford to enter more into detail; our idea was to show that notwithstanding prevailing impressions, that the works of the engineer should be made positively ugly, that they could and should be made positively pleasing, and be built in architectural and in an artistic manner. Not alone large structures as bridges of long span, but the less imposing, as it is in just such works that art is mostly indeed.

As referred to in the beginning of this paper we maintained that engineering and architecture were co-existant, then why are they not taught together? It is only then that we could expect to see real artistic engineering, and we would not need to sigh, that engineering so deserving of art is so devoid of it.

Los Angelos, Cal., *May, 1877.*

A BILL TO SECURE GREATER SAFETY FOR PUBLIC TRAVEL OVER BRIDGES.

Section 1. *Be it enacted by the General Assembly of the State of Ohio:* That all railroad bridges hereafter erected and designed or used for public travel, except those provided for in section seventeen of this act, shall be built to carry, for usual loads, not less than the following, in addition to their own weight, viz.: Bridges having a span of seven and a half feet, and under, nine thousand pounds per lineal foot for each track; those having a span of from seven and a half to ten feet, seven thousand and five hundred pounds per lineal foot for each track; those having a span from ten to twelve and a half ft., six thousand and seven hundred pounds per lineal foot for each track; those having a span from twelve and a half to fifteen feet, six thousand pounds per lineal foot for each track; those having a span from fifteen to twenty feet, five thousand pounds per lineal foot for each track; those having a span from twenty to thirty feet, four thousand and three hundred pounds per lineal foot for each track; those having a span from thirty to forty feet, three thousand and seven hundred pounds per lineal foot for each track; those having a span from forty to fifty feet, three thousand and three hundred pounds per lineal foot for each track; those having a span from fifty to seventy-five feet, thirty-two hundred poudns per lineal foot for each track; those having a span from seventy-five to one hundred feet, thirty-one hundred pounds per lineal foot for each track; those having a span from one hundred to one hundred and fifty feet, three thousand pounds per lineal foot for each track; those having a span from one hundred and fifty to two hundred feet, twenty-nine hundred pounds per lineal foot for each track; those having a span from two hundred to three hundred feet, twenty-eight hundred pounds per lineal foot for each track; those having a span from three hundred to four hundred feet, twenty-seven hundred pounds per lineal foot for each track, those having a span from four hundred to five hundred feet, twenty-five hundred pounds per lineal foot for each track; and in all bridge trusses of whatever length, the several members in each panel shall be so proportioned as to sustain, in addition to its share of the uniform load as above stated, such concentrated panel load as is herein provided for a bridge of a length equal to the length of the panel.

Sec. 2. Every railroad bridge shall be so constructed as to be capable of carrying on each track, in addition to its own weight, two locomotives coupled together, each weighing ninety-one thousand and two hundred pounds, on drivers, in a space of twelve and a half feet for each locomotive, and said locomotives to be followed by cars weighing twenty-two hundred and fifty pounds per lineal foot, covering the remainder of the span; and all railroad bridges shall be so projected that the loads above mentioned in section one, shall not strain any part of the material in such structure beyone one-fifth its ultimate strength.

Sec. 3. All bridges hereafter erected, and designed or used for public travel, on any highway or wagon road, shall be constructed to carry, besides their own weight, not less than the following standard loads, namely: City and suburban bridges, and those over large rivers, where great concentration of weight is possible, and on highways in manufacturing districts, spans of thirty feet and under, one hundred and ten pounds per square foot; spans from thirty to fifty feet, one hundred pounds per square foot; spans from fifty to seventy-five feet, ninety pounds per square foot; spans from seventy-five to one hundred feet, eighty pounds per square foot; spans from one hundred to two hundred feet, seventy-five pounds per square foot; spans from two hundred to four hundred feet, sixty-five pounds per square feet; on all other highway or road bridges, the standard load shall be not less than one hundred pounds per square foot, in spans of thirty feet and under; ninety pounds per square foot, in spans from thirty to fifty feet; eighty pounds per square foot, in spans from fifty to seventy-five feet; seventy-five pounds per square foot, in spans from seventy-five to one hundred feet; sixty pounds per square foot, in spans from one hundred to two hundred feet; fifty pounds per square foot, in spans from two hundred to four hundred feet. The floor-beam strength for each floor-beam for each wagon-way of city bridges, and those near large manufactories, shall be not less than thirteen thousand and five hundred pounds; for other bridges not less than eleven thousand two hundred and fifty pounds.

Sec. 4. In the construction of all bridges for public travel, either for railroads or common wagon ways, the stress on any material used in the construction of the bridge, in carrying the maximum load for which such bridge is designed, shall not exceed the following, namely: For the best quality of wrought-iron, in tension, long bars or rods, ten thousand pounds per square inch; for short lengths, eight thousand pounds per square inch, and against shearing force, seven thousand and five hundred pounds per square inch; and for the best quality of wrought-iron, in beams either square or cylindrical in section, in compression, the following, namely: Beams having a length of ten diameters, eight thousand one hundred pounds per square inch, with square ends, and seven thousand four hundred pounds with round ends; beams having a length of from ten to fifteen diameters, seven thousand eight hundred pounds per square inch, for square ends, and six thousand and five hundred pounds for round ends; beams from fifteen to twenty diameters, seven thousand four hundred pounds per square inch for square ends, and five thousand five hundred pounds for round ends; beams from twenty to twenty-five diameters, seven thousand pounds per square inch for square ends, and four thousand and five hundred pounds for round ends; beams from twenty-five to thirty diameters, six thousand and five hundred pounds per square inch for square ends, and three thousand eight hundred pounds for round ends; beams from thirty to thirty-five diameters, six thousand pounds per square inch for square ends, and three thousand two hundred pounds for round ends; beams from thirty-five to forty diameters, five thousand five hundred pounds per square inch for square ends, and two thousand and seven hundred pounds for round ends; beams from forty to fifty diameters, four thousand and six hundred pounds per square inch for square ends, and twenty hundred pounds for round ends; beams having a length from fifty to sixty diameters, three thousand eight hundred pounds per square inch for square ends, and one thousand four pounds for round ends; beams having a length from sixty to seventy diameters, three thousand two hundred pounds per square inch for square ends, and one thousand one hundred pounds for round ends; and for beams from seventy to eighty diameters, two thousand seven hundred pounds per square inch for square ends, and nine hundred pounds for round ends. If iron inferior to the best quality be used, either in tension or compression, the stress on the same shall be proportionately less than the foregoing standard for wrought iron of the best quality.

Sec. 5. Cast iron may be used in the construction of bridges, in compression only, and in lengths not exceeding twenty diameters, at the same stresses as those prescribed for wrought iron by this act, and in shapes other than square or cylindrical, whether wrought or cast iron be used, the stresses shall vary accordingly.

Sec. 6. Where wood is used in the construction of any such bridge, as aforesaid, the greatest allowable strains shall not exceed the following, namely: For oak in tension, twelve hundred pounds per square inch; for pine, one thousand pounds per square inch; and in compression, for oak beams of ten diameters, one thousand pounds per square inch; and for pine, nine hundred pounds per square inch; for oak beams from ten to twenty diameters, eight hundred pounds per square inch, and seven hundred pounds for pine; for oak beams from twenty to thirty diameters, six hundred pounds per square inch, and five hundred pounds for pine; and in oak beams of from thirty to forty diameters, four hundred pounds per square inch, and three hundred pounds for pine.

Sec. 7. It shall be the duty of all railroad companies or other corporations erecting a bridge for public travel, whether by contract or otherwise, to keep on the spot a competent engineer to superintend the work, who shall have power to reject any piece of material which may have been injured or which may be imperfect from any cause.

Sec. 8. All railroad bridges in this state used for public travel and having over a fifteen foot span, or having a truss, shall be inspected once every month by some competent person appointed by and in the employment of the corporation owning or using the bridge, for the purpose of seeing that all iron posts are in order, and all nuts screwed home, that there are no loose rivets, that iron rails are in line and without wide joints, that the abutments and piers are in good condition, that the track rails are smooth, and that all wooden parts of the structure are sound and in proper condition, and that the bridge is safe and sound in every respect. The person so inspecting railroad bridges, shall, as often as once in two months, make report, under oath, giving a detailed statement of the condition of each bridge to the general manager or superintendent of the rail-

road company employing him, who shall forthwith forward the same to the commissioner of railroads and telegraphs, and such inspection, in whole or in part, shall be made and reported as aforesaid oftener than once in two months, if required by said commissioner, and it shall be the duty of said commissioner to prescribe the form of blanks to be used by such inspectors of railroad bridges, embracing such information as said commissioner may desire.

SEC. 9. All highway bridges for public travel of more than twenty foot space, in or near any city, shall be carefully inspected as often as once in three months, and all other of such bridges having more than twenty foot span as often as once in six months, by some competent and suitable person. For city bridges, the mayor shall appoint the inspector, and the reports shall be made to him, and filed and preserved in his office for public inspection. For county bridges, the county commissioners shall appoint the inspector, and such reports shall be made to the commissioners and filed and preserved in the auditor's office for the use of the public. For all turnpike bridges, such inspection shall be made by an inspector appointed by the company using the bridge, and report shall be made to the county commissioners of the proper county, and filed and kept as reports on county bridges. All reports shall be made under oath, and the mayor or county commissioners, as the case may be, shall allow the inspector such sum for his services as may be just, which shall be paid in the same manner as claims against the city or county are paid.

SEC. 10. All corporations operating lines of railroad in this state shall, within sixty days from the taking effect of this act, report to the commissioner of railroads and telegraphs, to be preserved in his office, a detailed description of all bridges in this state of more than fifteen foot span, or having a truss, on their respective lines, and used for public travel. Said report shall be under oath, and made by some competent person in the employment of such company, and shall include the name of the stream or obstacle spanned, its location in miles from the nearest prominent point on the road, with the number or other designation of each bridge, the number and length of spans, their strength, the dimensions of all its important members, abutments, and piers, with the kind of material used in the same, and the foundation, and the age of the bridge, and the date when any important changes or repairs were made in the bridge.

SEC. 11. The governor shall, on the nomination of the commissioner of railroads and telegraphs, with the advice and consent of the senate, appoint some competent expert, at a salary not exceeding three thousand dollars a year, who shall have cognizance of the construction and maintenance of every bridge intended for public travel in this state, and who shall hold his office for the period of five years, unless sooner dismissed by order of the governor for reasons affecting his efficiency, in which case such reasons shall be given in writing by the governor, and shall be entered in full upon the public records in his office.

Such expert, before he shall enter upon the discharge of the duties of his office, shall pass a successful examination as to his mathematical and mechanical competency before a committee of three members of the American Society of Civil Engineers, and receive their endorsement in that behalf; and he shall, moreover, take and subscribe the following oath, to be administered by some officer authorized to administer oaths in this state, "I, ————, do solemnly swear that I am not directly or indirectly interested in any railroad or turnpike company, or any bridge company, or bridge patent, or in the manufacture or sale of any bridge materials, and that during my continuance in the office of inspector I will not become so interested, and that I will honestly and faithfully perform, with my best skill and ability, every duty in said office, without fear, favor, or affection, so help me God." Said oath shall be filed and recorded in the office of the governor.

SEC. 12. Said expert shall be subject to the direction of the commissioner of railroads and telegraphs, and all papers, calculations, reports, etc., pertaining to bridges, shall be filed and preserved in the office of said commissioner. It shall be the duty of said commissioner, whenever he is notified, or shall receive information, whether official or otherwise, or shall have reason to suspect that any railroad bridge, or any other important bridge is defective, to immediately cause the same to be inspected by said expert, and if found unsafe, he shall prohibit its use till put in safe condition and so pronounced by said expert.

SEC. 13. All railroad or turnpike officials having in charge the letting and construction of any bridge of more than fifteen foot span, or having a truss, and all county and state officials having in charge the letting or construction of any highway bridge or bridges of more than thirty-five foot span, shall submit to said expert a strain sheet and drawings of the proposed structure before work has commenced thereon, who shall examine and certify its correctness if correct, and make such alterations as may be necessary, if it be faulty in design, or scanty in materials, according to the standard prescribed in this act; and on the completion of such bridge, said expert shall critically examine the work in all its details, comparing and verifying the sections on the strain sheet with those of the actual structure, and if these last are unsufficient, to forbid the use of the work till the bridge is made sufficiently safe and strong. A copy of all plans and strain sheets submitted to said expert, shall be preserved in the office of the commission of railroads and telegraphs, and changes made from time to time, shall be noted on the records or files of said office.

SEC. 14. If said bridge, examined as mentioned in the last section, is up to the standard in all its parts, said expert shall give triplicate certificates to that effect: one to the builder, one to be filed in the office of the commissioners of railroads and telegraphs, and if a railroad bridge, the third certificate shall be given to the railroad company; if a highway bridge then a tablet shall be placed on a conspicuous part thereof, containing the third certificate, and also the names of the builders, the name of the officer or officers who accepted the work, the strength of the bridge as designed, and the year of its erection. Any person who shall willfully injure and fraudulently destroy such tablet shall be deemed guilty of a misdemeanor, and, on conviction thereof shall be imprisoned in the county jail not more than six nor less than three months.

SEC. 15. In all cases there may be an appeal from the decision of said expert to the commissioner of rail roads and telegraphs, who shall carefully enquire into the matter in dispute; and any modifications of the orders or decisions of said expert, or, changes ordered or made by said commissioner, shall be in writing, and spread upon the records in his office; and if said expert, from press of official business or other cause, shall require assistance, said commissioner may, from time to time, employ such assistance as he may deem proper, and pay for the same out of his contingent fund.

SEC. 16. It shall be the duty of the commissioner of railroads and telegraphs to stop the running of trains on all railroads in this state, where the company or companies operating the same either neglect or refuse to comply with the provisions of this act; and in case of injury to person or property, by reason of defect in any bridge in this state, this act shall not be construed or have the effect to diminish the liability of any corporation or authority, at the time of such injury, using the same. Any person willfully taking a false affidavit, under any of the provisions or requirements of this act, shall, on conviction thereof, be imprisoned in the penitentiary, at hard labor, not more than ten nor less than one year; and any person stealing, concealing or suppressing, or fraudulently destroying any paper, calculation, plan, or other thing, required to be kept in the office of the commissioner of railroads and telegraphs, shall, on conviction thereof, be imprisoned in the penitentiary, at hard labor, not more than three years nor less than one year.

SEC. 17. The standard loads on bridges of narrow gauge railways shall be thirty per cent. less than those provided in the preceding sections of this act. The word "bridge," in this act shall be held to include trestle work, each span of trestle being accounted as a separate bridge.

SEC. 18. This act shall take effect and be in force from and after the 10th day of May, 1877.

THE Louisville Bridge and Iron Company has the contract for three double track through wrought iron triangular truss spans, each 142 feet long, over White River, on line of Belt Railroad at Indianapolis, Ind.

ON THE MOUTHS OF THE DANUBE, AND THE IMPROVEMENT OF THE MOUTHS OF RIVERS IN NON-TIDAL SEAS.*

BY MAJOR STOKES, R. E.

The object of this paper is to bring before the officers of the corps the different methods that have been used for removing the bars of rivers discharging into non-tidal seas, with which the author has become acquainted whilst employed on a special duty.

He purposes first to treat of the general causes which lead to the formation of bars, and of the means to be employed for their removal.

Secondly, to mention generally the special treatment to which the bars of different rivers have been subjected.

Thirdly, to give a more detailed account of the works that have been successfully applied at the mouth of the Danube.

Round the mouths of most rivers are found shoals formed of the deposits of the river, and modified by the batter of the waves during rough weather; through these shoals the river forces a channel, which has greater or less depth, according to the state of the river and the sea. As this channel rises as a ridge between the deep waters of the river and the sea within and without it, and connects the higher shoals lying right and left of it, it resembles the neck connecting two hills in the same range; and though really a channel, is called the bar.

The height of the bar or depth of the channel, varies, as has just been said, under different conditions of the river and sea. When the flood waters of the river come down loaded with mud and sand they meet with a check at this ridge, but their impetus being greater than in ordinary times, the ridge itself is generally pushed farther out to sea, and the river waters being still further retarded by the opposing stationary mass into which they issue, the particles hitherto hurried along begin to fall to the bottom as the force of the current grows less and less, thus, on the new ridge, pushed out as above described, falls the coarse sand, making it grow up to larger dimensions than the original bar; further out will be the fine sand; and in the depths far out to sea will invariably be found mud and fine silt if the river flows through an alluvial soil. Should these flood waters be accompanied by a land wind, it is evident that the effect on the entry will be less injurious, the current being increased will carry the opposite ridge or bar farther out into deeper water, where the new ridge will require a larger base, and, consequently, take a longer time to grow; and the strength of the current will also carry the deposits further out to sea, and the shoals formed by them will be less dangerous to navigators.

If the floods occur at a time when gales are blowing into the mouth, the force of the current is checked, the bar is pushed out comparatively but a short distance, the deposits of the checked river are more immediately thrown down, and there is a greater danger of the formation of new and extensive shoals beyond and round the entry. After the subsidence of these floods the action of the waves generally drives the bar back to its original position after a struggle of weeks or months, according as the wind may prevail most from seaward or landward, and the fresh shoals are in the same manner driven in and piled upon the coast line, causing it to advance seaward. The case hitherto considered is that of a river issuing into the sea without littoral currents under different conditions of the wind; should, however, the sea have a constant current in one direction, a very important element is introduced, and the formation of shoals and growth of the bar may be brought under control.

As most rivers date from the remotest times, it is, of course, difficult to show their *first* effects, or to prove any theory of the formation of their bars; the author, however, calls attention to the following example which may tend to throw light upon the subject.

The river Vistula discharges into the Baltic by several branches, of which the western and most important formerly debouched into the Gulf of Dantzic, below the fortress of that name; the course of this branch was singular, it approached the coast in a direct line to the sea, to a point within 700 yards of it, when it took a sudden bend away from the coast and finally found its

* A Paper read at Chatham, England, October 16th, 1863.

way into the Gulf, at a point more than five miles further along the coast to the west. In the spring of 1840, however, the break up of the ice on the Vistula began from above, and immense blocks of ice were piled up in the bend above mentioned, until they formed a high dam which held back the flood waters of the river, and threw their weight upon a line of sand hills about 50 to 70 feet in height, which separated the river from the sea. Thirty-six hours of this pressure sufficed to the raging waters to break through this barrier, and ever since the western branch of the Vistula has debouched into the Baltic at this point; the channel which it broke through was, at first, 16 to 17 feet deep, but as the river current decreased, its deposits were thrown down and a bar formed so that only a channel of 6 to 7 feet remained.

The existence of bars may then be briefly resumed as due to two causes:—

1. The deposit of matter from the flood-waters of the river.

2. The effort of the sea to maintain the coast line by throwing up and packing together the sand and shells at its bottom.

The variety and amount of effect produced by these causes depend upon the action of the winds and currents, and on the changing force, duration, and direction, from which we may deduce the following axioms:—

1. That the mouth of every river has its own local peculiarities on which the successful treatment of it must depend.

2. That in studying to apply general principles to the improvement of any river, its local conditions must alone be allowed to guide such application.

That the fact of works having proved successful, or having failed at any river mouth, by no means ensures that the same kind of works will succeed at any other river mouth, unless the very same conditions exist.

We now proceed to consider the different remedies proposed for the removal of bars, or, more properly speaking, for the attainment of a deep navigable channel into rivers whose entrance are obstructed by bars.

These remedies may be briefly stated thus:—

1. By cutting a channel and maintaining it by dredging, assisted by the use of a rake towed over the channel.

2. By confining the river waters between piers which lead them across the bar and into deep water.

3. By cutting a canal to connect the sea with the river above its mouth, the river waters to be excluded from the canal to prevent its being silted up, the canal to lead into deep sea between piers, and kept clear by dredging.

The first of these methods may be practiced with advantage only where the channel to be dredged lies in a bay or gulf sheltered from the action of the waves. On an open coast, exposed to the swell produced by every breeze, a dredger cannot produce any perceptible effect. The least swell prevents her working, and for one day's perfect calm she will have two days of swell, even in summer, so that the work of one day is liable to be filled up the next; if, by the end of autumn, some little effect is produced, the long cessation of work during the winter months will certainly leave the waves at liberty to fill up the deepened channel.

A thorough trial was given to this system at the Sulina mouth of the Danube, in the summer of 1857, when three months constant dredging, relaxed only when there were too much swell on for work, gave no more than six inches additional depth, which was soon lost in the following months, although ther were then no floods to throw down deposit. The beating of the waves did the work, for the coast at Sulina is entirely exposed to all of the prevailing winds.

It is to be remarked that this dredging did not aim at the removal of the stuff in barges. In the narrow channel where the dredger worked there was not room for barges to lie alongside of her; even the dredger herself was frequently run into by vessels passing in and out. The stuff dredged was allowed to fall on a grating, and being thus broken up was carried away by the river current into which it fell.

At the canal entry to the Vistula, of which mention will be made further on, a dredger works successfully every day from May to October or November, but the ground on which she works is entirely protected from the prevailing winds.

In the channel at the mouth of the Oder, a dredger is also kept at work with good effect to prevent the growth of the sand bank by which it is sheltered while working.

Both at Sulina and off the Vistula the presence of the dredger has been found to be a great inconvenience to the navigation. At Sulina there was no advantage gained to counterbalance the annoyance and expense of the dredger; at the Dantzic canal entrance the maintainance of a channel 17 feet compensates the navigation for both.

Examples of the second method, namely, that of parallel piers, are to be found at the mouths of the Oder, Rhone, Danube, and Vistula. In the first and third instances they have been successfully applied, in the second and fourth unsuccessfully. The reasons for these various results will now be traced.

The Oder, not long before reaching the Baltic, passes through a lake called the Haff in which it deposits any of the matter that it may hold in suspensoin, and whence it continues its remaining short course to the sea in a clear and limpid stream. The bar, or rather the menacing sand bank at its mouth, is formed by the littoral current which attacks the line of high dunes extending westward for a distance of 12 miles, and brings in the sand which accumulates so fast to the west of the entrance, thereby necessitating the employment of a powerful dredger to keep this bank from growing inwards.

An examination of the charts of this mouth, which have kept for the last 120 years, shows that in 1739 there was only six to seven feet in the entry. From that time till 1776, efforts were made to render the banks at the mouth more solid, and to bring them closer together by groins of fascine work, which collected the sands travelling along the coast, and a survey of that year shows that this system had led to a considerable advance in the coast, and to but a slight improvement in the depth, which seems to have been its condition in the year 1816. At this time it was determined to have recourse to piers, and the works of that nature then commenced were steadily carried forward for nine years with an ever-increasing depth in the navigable channel, until in the year 1825, when the piers were completed, there was a channel of 17½ feet, which went on improving, till in 1845 we find a fair channel of 24 to 27 feet to the north-east, and a very broad channel of 18 feet to the north. It will be seen, however, that although this channel was cut through the old bar by the river current concentrated and directed by the piers, a part of that bar always remained in the shape of a sand bank running out beyond the west pier. It must be clearly understood that this bank, on which great stress has been laid by those who pretend that the piers have failed, is *not* a new formation; it's growth has, from time to time, tended to render the navigable entrance narrower, but, as has been observed above, it has ever been removed by the action of the current aided by dredging, so that in 1858, 33 years after the completion of the piers, the 18-ft. channel had always been maintained without any prolongation of them, and there was still a fair 24-ft. channel for steamers. It was then in contemplation to prolong the western pier in a direction converging on the eastern pier, so as to increase the scour, and check the travel of the sands along the coast from west to east.

It will now be useful to explain the causes of the bar forming at the mouth of the Oder, and of the great success of the piers.

The bar was formed, and the west pier sand bank is increased, by the travelling sand carried eastwards from the western head-land of the bay (into which the Oder discharges), by the littoral current. Some of the dunes attacked by the current are 200 feet high, and several of these big sand hills have been degraded at the rate of 12 feet a year. This littoral current circulates round the Baltic, from Denmark along the north coast of Prussia by Russia and Finland, returning down the coast of Sweden. It is urged forward by the prevailing westerly winds, but is at times held back by north-easterly gales, which, by banking up the waters, cause the sea-level to rise and the sea-water to pour into the haffs or lakes. When the gales abate and the prevailing winds and currents cause the sea-level to fall again suddenly, the waters of the Haff pour rapidly out through the Oder mouth, at the rate, generally, of some five miles an hour for some three or four days; this great scour, which recurs at not very long intervals, has served to maintain the channel, and to cut down the bank growing under the influence of the travelling sands. It is unaccompanied by any deposit on the bar, as the waters are quite clear, being, in fact, sea-water escaping back from the Haff. These peculiar conditions of the Oder mouth deprive the results gained by the piers of some of their value, as experience gained for the general question; but these results are, on the other hand, conclusive against the assertion that the works have failed of their object. The substitution of a channel 18 to 24 feet deep, maintained for 33 years, for one from 8 to 12 feet deep, must be allowed to be a success. The prolongation of the piers from time to time will, of course be necessary; but, if only required once in thirty years, the expense will be fully compensated by the results obtained.

At the mouth of the Rhone, piers have been projected, but the plan never advanced beyond the embankment of the river. It will be well to examine the causes that lead to the abandonment of the scheme.

The Rhone discharges through several mouths into the gulf of Lyons; the deepest natural outlet, and that by which the greatest body of water passes, is the easterly mouth. This mouth discharges in a direction exactly opposed to the prevailing winds, so that when the floods descend they find themselves immediately arrested, and the matter held in suspension is at once thrown down close to the mouth. At the same time, it must be observed, that the usual force of the current is very feeble, being less than a mile an hour, so that it has no chance of forcing a way through banks formed during the floods; and, on the other hand, the winter gales breaking directly on these banks pack and consolidate them, so that they advance, in their natural state, 40 to 50 yards a year. So feeble is the current, that the river, for 2½ miles above the point where it joins the sea, does not maintain the depth of 26 to 30 feet that it has higher up, and which here falls to 14 or 15 feet.

So much for the natural conditions of the river mouth, conditions the most adverse to the pier system. If one, however, considers the works that were executed there from 1852 to 1857, one can hardly admit that the pier system failed at the mouth of the Rhone; for piers in the sense understood, at the mouths of the Danube and Oder, were never carried out.

(*To be continued.*)

IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.*

OFFICE OF UNITED STATES LAKE SURVEY,
Detroit, Mich., April 5, 1877.

SIR: I have the honor to report the condition of the works carried on by J. B. Eads, for the improvement of the South Pass of the Mississippi River, on March 16, 1877. My last report gave their condition on November, 18, 1876.

REVERSE CURRENTS IN SOUTH PASS.

From time to time observations have been made to detect the existence of reverse salt-water currents underlying the fresh water in the South Pass, as such currents might have influence in maintaining a channel. It is well known that the tides in the Gulf of Mexico almost entirely disappear when the moon has zero declination, and reach their greatest values (about 1.5 feet mean rise and fall) when the moon has her maximum declination, either north or south. It would naturally be expected in a very low stage of the river that the high tides should send a considerable amount of salt water into the river; at times when there was no tide, less salt water would enter it, and at high stages of the river little or none. (Extreme low river reads —1.60 feet on the gauge at Carrollton, near New Orleans, and extreme high river reads + 15.70 feet. The specific gravity of fresh water being 1.000, that of sea water is 1.027.) Thus at South Pass light-house, on August 15, 1876, salt water was found on the bottom for the first time. Rise and fall of tide that day 1.72 feet, Carrollton gauge reading 7.60 feet.

On September 17, with a tide of 1.2 feet, salt water of

* From the Sixth Report upon the Improvement of the South Pass of the Mississippi River, by C. B. Comstock, Major of Engineers, Bvt. Brig. Gen. U. S. A.

specific gravity 1.010 was again found on the bottom, the Carrollton gauge reading 3.00 feet.

But on October 2, 1876, with only 0.3 foot rise and fall of tide, and Carrollton gauge reading 4.80 feet, brackishness at bottom was barely perceptible, the specific gravity being only 1.001.

On October 11, with a tidal rise and fall of 1.2 feet, the Carrollton gauge reading 5.35 feet, the specific gravity of water at bottom rose to 1.014 at nine hours before high tide.

On January 3, 1877, with a tide of 1.26 feet, the Carrollton gauge reading—0.60 foot, no reverse current was found three hours after low tide, but specific gravity at 28 feet depth was 1.013.

January 7, 1877, with tide of 1 foot and Carrollton gauge reading —0.80 foot at two hours before high water, there was a reverse current with a velocity of 0.7 foot per second at 15 feet below the surface, specific gravity 1.000 at surface, and 1.012 at 27 feet depth.

January 11, 1877, with a tidal rise and fall of 1.65 feet, the Carrollton gauge reading—1.00 foot at an hour before high water, there was a reverse current of 1.06 feet at 20 feet below the surface. Specific gravity at 27 feet was 1.012.

January 13, 1877, with a tide of 1.62 feet, Carrollton gauge reading —0.60 foot, there was, at four hours before high water, a reverse current with a velocity of 0.55 foot at 20 feet below the surface, the specific gravity being 1.006 at that depth.

January 15, 1877, with a tide of 1.65 feet rise and fall, the Carrollton gauge reading —0.30 foot, there was a reverse current of 0.71 foot at 20 feet below the surface.

January 19, 1877, with a tidal rise and fall of 0.75 feet, the Carrollton gauge reading —0.50 feet, there was a slight reverse current below 17 feet depth. Observation ten hours before high water.

January 26, 1877, with a tidal rise and fall during the day of 1.9 feet, the Carrollton gauge reading 1.40 feet, and the river rapidly rising, there was at two hours before high water, no salt water at any depth.

On January 7, 11, 13, and 15, the surface current was direct, and varied between 0.18 foot and 1.29 feet per second. It will be noticed that on January 11, 13, and 15, the velocities near the neutral plane changed very rapidly with changing depth. Possibly a part of this may be due to errors of observation. A Woltmann's wheel would probably have given more exact results if one had been available.

The data thus far given are all for the immediate vicinity of the South Pass light-house.

A few observations were made at the head of South Pass, near the lower end of Goat Island. Thus, on December 11, 1876, the water, at the depth of 35 feet, had a specific gravity of 1.016; Carrollton gauge read 0.75 foot.

January 24, 1877, at 35 feet depth, specific gravity was 1,008; Carrollton gauge, —0.30 foot.

From these observations it follows that at periods when the river stage is very low and the tides are the largest, there is, prior to high tides, a considerable upstream flow of sub-surface salt water past the South Pass light-house, the velocity of this flow sometimes exceeding a foot per second.

This salt water is found at the head of South Pass, and it doubtless extends far up the river in low stages. It would be of interest to ascend the river, when again low, to a point where the water is 100 feet in depth, and ascertain the amount of salt water there.

RECAPITULATION.

At the mouth of the South Pass, between November 18, 1876 and March 16, 1877, a few new wing-dams have been built, and some old ones repaired. About 16,000 cubic yards of material have been dredged out at points where the channel was worst. A storm of December 30, 1876, damaged the ends of the jetties and the wing-dams near them quite severely. 2,600 feet of the west jetty has been raised by mattresses 2 or 3 feet thick built in place; a layer of stone 0.8 foot thick on this portion gives it a height varying between 0.5 foot and 2.0 feet above average flood-tide. The outer end of this part is 700 feet from the sea end of the jetty; 167 new piles have been driven in the jetty.

Little work has been done on the east jetty.

The channel of 20 feet in depth at the mouth of South Pass, which on December 27, 1876, had a width of 200 feet from the Pass to the Gulf, has narrowed at a point near the sea end of the jetties so as to be but 70 feet in width, and at a point a little below the head of the west jetty, so as to be 180 feet in width.

At the head of the passes, the west T-head has been extended up-stream to meet the line of mattresses across the head of Southwest Pass, and its upper part has been made a solid dike. A line of mattresses has been carried from the east T-head down to the head of Goat Island. A solid mattress-dam (No. 6) has been built across the old east entrance to South Pass. About 30,000 cubic yards of dredging has been done, (making the total amount of dredging here 40,000 or 50,000 cubic yards). The river began to rise on January 24, and caused a sharp scour between the T-heads, so that 23.9 ft. could be taken from the Mississippi River into the South Pass on March 7, 1877.

Very respectfully, your obd't servant,

C. B. COMSTOCK,

Maj. of Engs. and Bvt. Brig. Gen. U. S. A.

The Hon. the SECRETARY OF WAR,

Washington, D. C.

STRENGTH OF BUILDINGS.

BY W. L. B. JENNEY, ARCHITECT.

The numerous accidents of late, both to public and to private buildings, naturally calls forth inquiry as to the cause of such disasters and the means of avoiding them in the future.

That they are unnecessary, no one for a moment doubts; but why are they so much more numerous than formerly? is a question of considerable interest at present, and which I think can be readily answered.

The accidents have happened to two classes of buildings—the one, large public edifices erected at great cost; the other, business warehouses. These two classes of accidents are due to very different causes and must be considered separately. Our new public buildings are built upon a much larger scale and are far more pretentious and costly than formerly and in consequence require more skill on the part of the designer and Superintendent. The day has past when a successful architect can grow up from an office-boy; he must now have a preliminary scientific training, and be as exact in his calculations of the different parts of an edifice as the engineer who designs a railroad bridge.

Every wall, pier, column, or beam in a building can be calculated, the maximum strains determined and such dimensions given to each detail of construction that the building shall not only be secure against accident, but shall be a homogeneous whole; that is, every part strong and no material wasted.

Such calculations to an engineer or architect accustomed to make them offer but few difficulties, and are sufficiently exact for all practical purposes; for, in order to avoid accidents from temporary overloading, defects in material or construction, a co-efficient of safety of from six to ten is introduced; that is the maximum load at any point shall not exceed one-sixth or one-tenth the crushing weight.

Unfortunately good designers and correct calculations are alone insufficient, for unless the work is properly erected, the building will be a failure and all the skill of the architect of no avail. Disaster may ensue and the architect be held criminally liable although he may have done his part equally well.

As an architect is generally superintendent of the execution of his own designs, the public quite naturally concludes that he has everything his own way, and is responsible for the workmanship of the several mechanics, the quality of the material, etc. This is true only within a very limited sense. The architect is the director of the work, but he is not paid to remain constantly at the building, to examine every bit of material that enters into the construction, and to see all work before it is covered up. This is the duty of a special employee, paid by the owners of the building, and known in England, where he is always employed on important constructions, as the "Clerk of the Works." He receives his instructions from the architect, explains the designs to the mechanics, and exercises a constant watchfulness over everything about the building. It is to be regretted that it is not the rule rather than the exception in the United States to employ a Clerk of the Works. It is the only way that the architect can know that his designs and specifications are being carried out in their true spirit and intent.

The second class of accidents, those to heavy wholesale warehouses, are usually due to another cause.

These buildings are erected as an investment, and, in consequence, must not cost more than a certain sum or it would be better to sell the ground or let it lie idle. But any increase in strength involves an increased amount of material, involving increased cost; therefore the tendency is to make the buildings light. If the architect does his duty by himself and his client, he will carefully calculate every part of the building, and notify the owner of the amount per square foot of floor that the building is calculated to safely carry—and this sum should be stated in the lease as the maximum load a tenant shall place in the building, and forcing upon said tenant all the responsibility of overloading.

Our city stores as usually built can be safely loaded with seventy pounds per square foot of floor, which being equivalent to the weight of a crowd of persons, is the lightest weight that any building should be calculated to carry, or otherwise a sudden rush from mere curiosity, or even an auction sale, might cover the floors with people and cause a frightful disaster. It would not be profitable to erect a building for a wholesale dry-goods store strong enough for a grocery or paper warehouse; and yet, if there are not some restrictions, a building sufficiently strong for the purposes for which it was designed may be greatly overloaded and disaster ensue. This is now the more likely to occur on account of the general use of steam or water elevators, which render all parts of a building equally accessible, and the upper stories, formerly used only for the lightest material, are more often stored with the heaviest goods, for in the busy season all our wholesale houses are liable to be short of room, and goods once on the elevator are taken to any story where there may be room for them.

It is well known that there are buildings in this city that have been overloaded, and dangerously so. Ignorance is the only cause for such recklessness, and the principle object of this paper is to call the attention of all interested in wholesale warehouses or buildings heavily loaded, to the fact that it is very easy to calculate exactly what is the safe load per square foot of floor, and as every dealer knows the weight of the goods he handles, it becomes a very simple problem to avoid overloading his building.

The business of our wholesale merchants is doubtless on the increase, and a busy season near at hand, and unless care and study is given to the question of loading buildings there will be a list of accidents involving loss of life and property.

Not many months since I was called upon to report the strength of a building used as a wholesale grocery. The building that could safely carry no more than seventy pounds per square foot of floor I found loaded with 200 pounds per square foot over considerable areas. Even during the few days that I was examining the building and making the calculations for strengthening it, marked changes took place that suggested the immediate necessity of blocking and jack-screws, and had not the tenant and owners acted with promptness a very severe accident would have occurred. And yet, as I was informed this building had been in use as a grocery warehouse for two years, and was at the time of examination loaded rather less heavily than usual.

Because a building has stood for a considerable period under excessive loads is no reason that it will continue to do so, for excessive loading weakens the construction and is a permanent injury.

We all remember not long since that the contents of a wholesale grocery on Randolph street was found one morning, floor, timbers, and all, in the basement. How long had the members of the firm and their employes run the risk of their lives every moment they were within the building? The same thing happened in New York only a few weeks since. We can scarcely expect that many cases of this kind will happen in the night; indeed, there is more reason that they should happen during the day, while the elevator is running and goods are being moved about, causing certain vibrations that materially increase the danger.

Tenants of loaded buildings must be watchful, especially if they are piling into them three times as much as they are intended to carry, and remember that it is the last straw that breaks the camel's back.—*Chicago Tribune.*

WE call the attention of our readers to the change in the address of the American Society of Civil Engineers, which will be until further notice 104 East 20th street, New York City. The following elections, changes and corrections in members' addresses are recorded for the month of April:

Additions:—James Dun, North Springfield, Mo.; Wheeler C. Durham, Civil Eng., Chicago, Ill.; Mordecai T. Endicott, Civil Eng. U. S. Navy, New London, Conn.; Bryant Godwin, Res. Eng., N. Y. State Canals, 551 Broadway, Albany, N. Y.; Arthur S. Hardy, Prof. Civ. Eng., Chandler Sci. Dept., Dartmouth College, Hanover, N. H.; George O. Knapp, Civil Eng., Hartford, Conn.; Nathan M. McDowell, City Eng., Allegheny City, Pa.

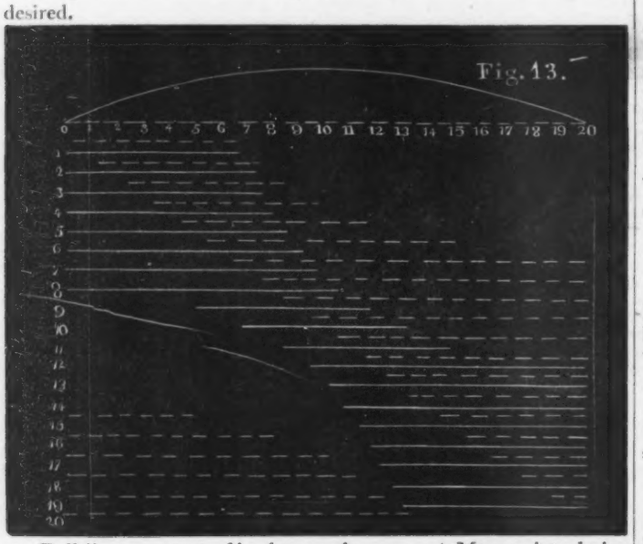
Changes and Corrections:—John Bogart, Sup'g Eng. Dept. Public Parks, 42 West 26th st., New York; Chas. O. Brown, Eng. Passaic Rolling Mill Co., 130 Chambers st., New York; William H. Burr, 50 Second st., Troy, N. Y.; Samuel H. Chittenden, East River, Conn.; Jacob M. Clark, Eng. C. R. R. of N. J., 119 Liberty st., New York; Richard D. Dodge, 58 Clark st., Brooklyn, N. Y.; Edmund L. Du Barry, 205 Hoffman st., Baltimore, Md.; James P. Gould, Eng. U. & D. and R. & C. R. R., Roundout, N. Y.; Alexander L. Holley, 56 Broadway, New York; Thomas Lafon, Newark (Knox Co.), Mo.; John McGee, Steubenville, O.; James Moore, Sup't C. R. R. of N. J., Elizabeth, N. J.; John Nader, City Eng., Madison, Wis.; Othniel F. Nichols, 112 Cambridge Place, Brooklyn, N. Y.; Stacy B. Opdyke, Jr., Ass't Eng. P. R. R., Lewiston, Pa.; Henry G. Prout, Lieut. Col. of 'Engs', Army of the Khedive, Vice Governor General of the Soudan, Egypt; Robert L. Read, Chief Eng., U. R. R., Transfer and Stock Y'd Co., Indianapolis, Ind.; Joseph Sewall, City Eng., St. Paul, Minn.; Herbert J. Shedd, 65 Westminster, st., Providence, R. I.; Edgar B. Van Winkle, "Rockingham," 56th st., and Broadway, New York; Charles D. Ward, 39 Hudson st., Jersey City, N. J.; David W. Wellman, Civil Eng., St. Paul, Minn.

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 124.*)

while that from H depends on k and the inclination of the rib, it will not be easy to determine a general expression for the amount of load to produce the maximum stress in either flange. In working out any particular design it may be as well to determine the stress in each part of the flanges at first from a single load at a point of division, tabulate the stresses in place of bending moments, and add together those of like sign in order to obtain the maxima desired.



Full line = extent of load to produce max. + M on points designated.

Broken line = equals extent of load to produce max. + F between points designated.

Blank space for max. — M. do. do. for max. — F.

64. It may be useful to make a little numerical calculation on the rib of Fig. 11, 100 ft. span and 20 ft. rise, supposing it to be loaded with the four weights only which are shown in the figure. The maximum positive moment is plainly at 8. If the rib is made of a web and two flanges 2½ feet from centre to centre, what will be, with this load, the stress in each flange? If our figure were larger, we could scale the ordinate above 8 and get the bending moment directly, bnt, as the sketch is small we will refer to the table. We thus find that

$M = (.0815\times2+.1715\times4+.0019\times2-.0833\times3)\,50 = 34.31$ ft. tons.

Dividing by 2½ ft., the depth of the rib, we get 13.72 tons, compression on the upper flange and tension on the lower flange. As the middle ordinate is 20 feet, the one at 8 will be $20\times\frac{16}{25} = 12.8$ ft., or 7.2 ft. less than the crown ordinate; the tangent at this point will strike the middle ordinate therefore at 7.2 ft. above the crown, and its length will be equal to $\sqrt{30^2+14.4^2} = 33.28$ ft. Therefore the direct thrust along the rib will come from the proportion T : H :: 33.28 : 30, or, since H was previously found to be 7.175 tons, T = 7.96 tons, on both flanges or 3.98 tons on each. We have then, finally:— Compression, at the point above 8, on the upper flange, = 13.72 + 3.98 = 17.7 tons; Tension, on the lower flange, = 13.72 — 3.98 = 9.74 tons. With a good-sized diagram, these results can be easily obtained graphically.

The diagram for shear for this arch with the given load may be drawn for practice, according to the explanations lately given. Draw first the diagram as if for a beam, and then, laying off the value of V, at each end for this particular case, draw a line from the ends of V, through the middle of the span. Note where the shear changes sign.

65. Passing next to the parabolic arch, fixed at the ends, we recall from § 28 that, to locate the curve of equilibrium for a single load at any point, we need three ordinates, one at each end, and the third passing through the point of attachment of the weight, and that the three conditions by which these must be obtained are, 1st., that the change of span shall equal zero; 2d., that the total change of inclination shall equal zero; and 3d., that the total deflection shall equal zero. As expressed in the notation used, the three equations of condition are

$$\Sigma\, E\,F\,.\,D\,E = 0, \qquad (4.)$$

$$\Sigma\, E\,F = 0, \qquad (6.)$$

$$\Sigma\, E\,F\,.\,D\,B = 0. \qquad (7.)$$

Since it will not be easy to adjust the lines by trial so as to satisfy these values, we will proceed to derive expressions for the required ordinates.

66. Let I N L represent the desired curve of equilibrium for a weight W, attached to the rib A Q B, Fig. 14, at a point distant T G, = b, horizontally from the middle of the span. Let the span A B = $2c$, A I = y_1, G N = y_0 and B L = y_2. If y_1 or y_2 becomes negative, it is to be laid off below A B, but otherwise above. The figure represents y_2 as negative, and, in the majority of cases, y_1 and y_2 have opposite signs. If the rise of the arch = k, and A D = x, D E will, as before, § 45, = $\frac{k}{c^2}(2c-x)x$. A G = $c+b$; G B = $c-b$.

Taking up the first condition, we have

$$\Sigma EF\,.\,DE = \Sigma\,(DE-DF)\,DE = 0, \quad \text{or}$$

$$\Sigma\,DE^2 = \Sigma\,DF\,.\,DE\,. \qquad (9.)$$

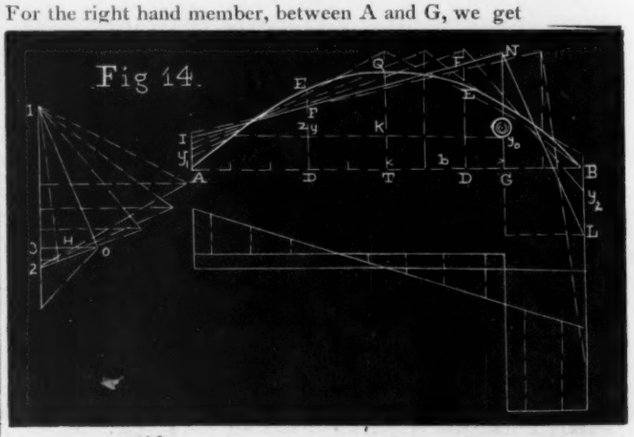
If a line be drawn horizontally from I, D F, as long as it is on the left of y_0, will be divided into a constant part y_1, and a remainder which varies with the distance from I. Therefore we see that

$$DF = y_1 + \frac{y_0-y_1}{c+b}x.$$

We get for the left hand member of (9.), when we introduce the sign of integration, exactly as in equation (10.), § 45,

$$\int_0^{2c}\frac{k^2}{c^4}(2cx-x^2)^2\,dx = \frac{16}{15}k^2c.$$

For the right hand member, between A and G, we get



$$\int_0^{c+b}\left(y_1+\frac{y_0-y_1}{c+b}x\right)\frac{k}{c^2}(2cx-x^2)\,dx =$$

$$\frac{k}{c^2}y_1\int_0^{c+b}(2cx-x^2)\,dx + \frac{k}{c^2}\cdot\frac{y_0-y_1}{c+b}\int_0^{c+b}(2cx^2-x^3)\,dx =$$

$$\frac{k}{c^2}y_1\left[c(c+b)^2-\tfrac{1}{3}(c+b)^3\right]+\frac{k}{c^2}(y_0-y_1)\left[\frac{2}{3}c(c+b)^2-\tfrac{1}{4}(c+b)^3\right]. \qquad [(e.)$$

For the portion between G and B, if we write $c-b$ for $c+b$, and reckon x from B to the left, we get

$$DF = y_2+\frac{y_0-y_2}{c-b}x,$$

the sign of y_2 being contained in the symbol. Then the integration for the right hand member of (9.), between B and G, or between the limits 0 and $c-b$, will give, when we substitute y_2 for y_1, and $c-b$ for $c+b$,

$$\frac{k}{c^2}y_2\left[c(c-b)^2-\tfrac{1}{3}(c-b)^3\right]+\frac{k}{c^2}(y_0-y_2)\left[\tfrac{2}{3}c(c-b)^2-\tfrac{1}{4}(c-b)^3\right]. \qquad [(f.)$$

The two portions (*e.*) and (*f.*) of the right hand member, being added together, when the coefficients of y_0, y_1, and y_2 are reduced, will be equated with the left hand member of (9.), giving

(*To be continued.*)

MOVABLE DAMS.

It is only quite recently that movable dams have been proposed in the United States, for the improvement of the Upper Ohio and the Kanawha Rivers, where it is desirable to make them deep enough to carry coal barges and rafts at low stages of water; and we think that few American engineers have a very clear idea of the details of such a construction and the methods of working. These dams have been introduced extensively upon French rivers, notably the Seine, the Yonne, the Marne, etc., as well as elsewhere, but as accounts of the structures built from time to time have been found heretofore only in the *Annales des Ponts et Chaussees*, they have not been accessible generally to inquirers in this country. It appears that, as long ago as 1818, Josiah White built a movable dam on the Lehigh river which was manœuvered solely by the pressure of the water; it consisted, we believe, of two gates; turning about horizontal axes at their lower ends, the upstream gate slanting down stream, resting upon and being supported by the lower one which inclined up stream. If the water between and below the two gates was permitted to escape, they revolved on their axes, falling one on the other, and leaving the passage open. This device is known as the "bear-trap." This dam was destroyed in the course of time and has well-nigh been forgotten.

For some fifty years various modes of constructing movable dams have been tried in the European rivers and many of the plans are very successful. Shutters turning about hinges at the bottom, wickets which revolve about horizontal axes a certain distance up, needles or bars removable by hand, caisson dams, etc., are to be found, some worked by hand, some by gears and chains, and some by hydraulic presses directly applied; in fact, the number of modifications reach some dozen or more. Perhaps the most accessible sources of information are the reports made to the Chief of Engineers, U. S. A., by General Weitzel and Col. Merrill, in the years 1874, 1875, and 1876, which give liberal extracts from foreign writers with plans and details. The report of the U. S. Commission to the Vienna Exhibition also contains an interesting account of two such dams.

Hagen, a prominent writer on hydraulics, in discussing the uses of movable dams and their importance, says:

"A complete solution of the problem seems to require that the pressure of the water, whether standing or flowing, should furnish the power by which the dam is erected or removed. Or, again, the construction must be such that, notwithstanding the requisite solidity of the structure, it can be managed with a slight power, for which only a few men and short time are required."

These dams are generally associated with locks to provide for the navigation up stream, and are sometimes intended to furnish a slack-water navigation of sufficient depth at low stages of the river. In this case the dam is only removed at times of comparative high water. But, in other cases, they are dropped to allow the passage of a number of barges, and closed again to cause the pond to fill. The barges then go rapidly forward on the artificial wave or *flash* which is created, and are thus carried in safety over what would be, otherwise, bars and shoals. One very curious circumstance is that the front of the wave, rolling over, as it were, travels faster than the remainder of the *flash*, so that the boats in advance can make a short stop at a landing below and still take the same wave again.

Hon. F. R. Brunot, of Pittsburgh, has devised a floating hydraulic gate which was recommended for trial in one of the dams of the Monongahela Navigation Company, and some description of this design may be found in the *Franklin Institute Journal*.

The construction of dams for the improvement of the Great Kanawha River is now in progress, although the deficiency in appropriations this year will retard the work. There are to be twelve dams in the 92 miles from its mouth at the Ohio River to Great Falls. In nine of them there will be passes, with movable wickets, opening a clear passage of 250 feet in length. Seven feet of water will be secured when they are closed, and the lift of most of the dams will also average seven feet. The three upper dams have a lift of 15 feet each and no movable portion.

As a type of the low lock and movable dam, we copy the description, given by the Chief of Engineers in the Report for 1876, of Dam No. 5, at Brownstown, some eight miles above Charleston, and now under construction.

"The lock, which is 364 feet in total length, 300 feet between hollow quoins, and 50 feet in clear width, is designed to pass at one lockage four coal-barges of the dimensions usual on the Ohio and Kanawha Rivers; that is, 130 feet long, 24 feet wide, and drawing 6 feet of water. It is placed in the river as near to its left bank as practicable, while giving a good exit and entrance for boats. The dam, about 560 feet long, crosses the river at right-angles to its direction, opposite the lower abutment, with a height from the rock of about 17 feet, and will raise the water nearly 11 feet above low water. The pass adjoins the lock, is 250 feet wide, and its floor is 50 feet long in the direction of the stream. The pier which separates the pass from the weir is 13.5 feet wide, 48 feet long, and 4 feet higher than the dam. The right bank of the river is protected by a masonry abutment, rising 10 feet above the dam, with wings extending to the top of the bank, above the reach of overflow.

"The lock walls will rest upon the rock, which at this point is between 3 and 4 feet lower than the mitre-sills. At the ends (the abutments for the gates) they will have a thickness of 16 feet, the interior faces will batter ¼ of an inch to the foot, the exterior faces will be vertical on the river side, while the back of the shore wall will batter 2 inches to the foot. Between the ends or abutments, the chamber walls are 12 feet thick at bottom of lock and 5 feet at top, the whole height being 20 feet; depth of water 7 feet, and lift of the lock 7 feet. The top of the lock is therefore 6 feet above the top of the dam.

"The upper and lower mitre-sills are placed on the same level, so that, by opening all the gates, the lock may serve as an extension of the pass. The mitre-sills are of stone, faced with timber; the floor of the lock is of concrete, covered with plank, except a space below each gate, which is paved with dressed stone. The angles, hollow quoins, mitre-sills, coping, etc., are of cut stone; the rest of the masonry will be of a much cheaper class, although not inferior in fitness, strength, or durability, all to be laid in the best manner in hydraulic cement. The chamber walls will be furnished with wings for the purpose of securing boats. The lock will be filled and emptied through valves in the gates, in addition to iron culvert pipes passing around the hollow quoins. It is proposed to build the gates of iron frames, covered with a sheathing of plank.

"In the lower abutment on the river-side is a well containing the gearing for tripping or throwing down the wickets of the navigation pass. This, as well as the chain-wells and gearing for operating the gates, is contained below the surface of the coping, and covered by iron plates; for, as the lock will be submerged in floods, it is necessary that no machinery or framing should be exposed on top of the walls.

"The floor of the pass is about three feet above the rock foundation. It is formed of concrete, supported front and rear by timbers framed into crib-work, the top is furnished with large timbers arranged to hold the journals, slides, etc., which are attached to them, and paved between the timbers with stone.

"The wicket is a wooden frame 13′ 5″ high and 3′ 8″ wide, covered with planks, and capable of revolving about an axis placed at the middle of its height. This axis is formed by the cross-head of an iron frame or *horse* which is itself movable about a horizontal axis fixed upon the floor. When a wicket is raised its foot rests against the sill of the floor, its horse is maintained vertical by an iron prop, the foot of which abuts against a *heurter*, an iron abutting piece fastened to the floor.

"The wickets, being placed side by side across the current, form, when raised, a dam to close the pass. A movable foot bridge is constructed up stream of the wickets, across the pass, to facilitate the operations of opening. To throw down or open a wicket, it is necessary to pull sidewise the foot of the prop, so that it shall slide across and clear of the front of the *heurter*. The prop, having lost its support, slides upon the floor down stream, the horse at the same time turns about its axis and falls upon the floor, the wicket follows them, and covers and protects the other pieces.

"If there is no water upon the floor, the wicket would be broken by the fall, but a very shallow cushion of water is sufficient in a great measure to destroy the shock. The foot of the *prop* is pulled away from the *heurter* by means of the tripping-bar, one end of which carries a rack gearing into a pinion in the well in the lock wall, worked by a crank on top.

"To raise the wickets, the lock-keeper stands upon the foot-bridge, and by means of a portable winch pulls up a chain attached to the foot of the wicket. The wicket rises, maintaining, however, a position nearly horizontal. It offers, therefore, but little resistance to the current. The *horse* and the *prop* follows its ascent until the foot of the latter, passing over the inclined plane which forms the top of the *heurter*, falls in front of it at the same time that the horse attains a vertical position. The axis of the wicket is now in its fixed position, and a slight push on the foot of it, or even the slacking of the chain, is enough to cause it to right itself and bear its foot against the sill."

In another column will be found some interesting remarks on the Tidal Waves which occasionally occur on our great Inland Lakes. We are now in possession of the confirmed report and many details of a similar disturbance of the waters of the Pacific Ocean on the coast of Peru and Bolivia, which took place on the 10th of May. The shock of an earthquake was first felt, when the ocean immediately upheaved, formed a wave some sixty feet high, and rushed shoreward with terrible velocity, destroying an immense amount of property, and, according to the reports, some 600 or 800 lives. Many of the villages and towns along the coast were completely overwhelmed.

One of the most prominent characteristics of the progress of civilization in the latter part of the nineteenth century is the rapid development of a taste for art in the masses, and the increasing demand for the production of such objects of art as the popular craving may require. While heretofore it has usually been the outside appearance of the house that has received the most attention, it speaks well for us that we are at last beginning to believe that the more beautiful we make the interior of our homes, the more sacred they become.

Demand necessitates supply, and the numerous art stores to be seen in all our large cities give unqualified evidence, not only of the bent, but the universal dominion, of this artistic craving of the age.

Among the many forms of art adaptable for house or garden decoration, and which has been brought within the means of the general public, is that class of statuary made from clay, or other material, or in the form of composition, foremost of which are the productions of John Rogers, of New York city. The peculiar eminence in this branch of art manufacture to which Mr. Rogers has attained, may be attributed as much to the truly artistic merit of the many works he produces, as to the excellence of the workmanship itself. There is always something lacking in the mere plaster cast of a work of art, a something which the sculptor's chisel seems alone capable of bestowing; yet in many of the beautiful groups of Rogers' statuary we have seen, we have been attracted towards them by the self-same spirit, doubtless, which inspired the artist when he designed them. Very true to nature in consequence of being very true to art, they form happy substitutes, in the place of such works as are entirely beyond the reach of any but the few, and present a means at a moderate cost, of decoration for indoor or out, which, when taste is displayed in their selection and disposition, gratify the senses and lend that charm to surroundings which culture at once requires and appreciates.

The catalogue embraces a large number of charming groups, as well as many pieces of less pretension and cost. The groups, as a rule, command attention by their artistic grouping, and the care with which the minutest detail is treated; the subjects generally are drawn from the historical incidents of late years, or from domestic sources, a variety which possesses the advantage not easily attained by a specialty, of affording ample scope to individual choice.

On those social occasions where custom has decided that some guarantee would be necessary in proof of regard, the most puzzling question is, what shall we give? A glance at Mr. Rogers' catalogue will, in most cases, determine an easy solution, and we think that in ordinary cases, not requiring special consideration, it will be found that nothing can be more appropriate than a group of his statuary, wherein will be found all that art requires in their production, spirit, truth and beauty, which, combined with the comparatively low cost, brings them within the reach of all.

We would advise all our readers to send for the Catalogue of John Rogers, 1155 Broadway, New York city.

ON THE MOUTHS OF THE DANUBE, AND THE IMPROVEMENT OF THE MOUTHS OF RIVERS IN NON-TIDAL SEAS.*

BY MAJOR STOKES, R. E.

(*Continued from page 138.*)

By the works executed, the engineers employed seem only to have sought to quicken the current whilst in the river; the works consists of dykes and causeways by which the outlets of six other branches have been closed and the river has been confined to one channel. Be-

*A Paper read at Chatham, England, October 16th, 1863.

yond the increase of power thus gained to the current, no step has been made towards removing the bar.

This method of proceeding has had the effect that might have been foreseen; the increased mass of river water has thrown an increased deposit; and the banks, instead of advancing at the rate of 40 to 50 yards a year, made in the year 1857 an advance of 300 yards forward.

In that year, the first after the complete embankment of the stream, the summer floods produced an increase of depth to 13½ feet, the former depth having been from 5 to 8 feet. This improvement lasted only four or five months, when the depth went gradually down to 7 feet. What the effect would be, of rapidly carrying out piers across the bar, as has been done at the Sulina mouth of the Danube, it is difficult to predict. The most violent winds blow directly into the mouth; and, for as much as 70 days out of 120, drive a heavy surf on to the bar. Still, the carrying of the river into the littoral current, which does cross the mouths from east to west, might have a beneficial effect. It is certain, however, that the Rhone offers but little chance of success to piers; it is also certain that they have never been really tried there. They cannot, therefore, be said to have failed at the mouth of the Rhone, though their failure *there* would constitute no argument against their employment elsewhere.

A project exists for entering the Rhone by a lateral canal from the Gulf of Foz, which, from its sheltered position, offers peculiar facilities for the execution of that class of work; the "Baie de Repos," into which the canal would debouch, being so calm at all times as not to interfere with dredging operations, and the bay itself having sufficient depth and a good bottom for anchorage.

The next example of the application of piers, which it is proposed to mention, is the Sulina mouth of the Danube; but, as the description of the works executed at this embouchure will form the subject of the concluding part of this paper, the author will here speak only of the results obtained by them, and of the general conditions of the locality which seem to him to have conduced to those results.

The Sulina is the least important of the three principle branches of the Danube, but it is that which has usually had the deepest navigable channel into the sea; its channel, from the point where it leaves the main river, 50 miles from the mouth, is the worst of the three branches, being everywhere narrow and in very many places encumbered by shoals which entail many delays and heavy expenses on vessels navigating from the principal ports of loading, namely, Galatz and Ibraila, whereas the other branches are broad and deep everywhere except at their mouths.

Without at this point referring to the circumstances which lead to the improvement of the Sulina mouth, it will suffice to say here, that the depth, on the Sulina bar before the improvements, was very variable, being sometimes as great as 12 feet, at others as low as 7½ feet; that the ordinary depth was from 9½ to 11 feet, and that it was more rarely about 10½ than below 9½ feet, and more frequently below 8½ than above 11 feet; that since the construction of piers the depth has never been less than 16 feet, and is usually 17 feet, there having been at times a good channel of 17½ feet.

The works commenced in April, 1858, were completed in August, 1861. The spring floods of that year had formed a menacing bank on the continuation of the south pier, and about 2,500 feet to seaward of it, but this bank was speedily broken down by the spring gales and carried away by the littoral current. In 1862, the floods threw down a similar bank, but without obstructing the navigation, and that bank was again removed by the action of storms, and currents. The supposition that a bar would form again outside the piers has not been in any way confirmed. The banks just mentioned have been the nearest approach to such a formation; but the rapidity with which they were removed seems to favor the supposition that the bar will only creep across the front of the piers when the general advance of the Delta shall have pushed the littoral current further away from them, and thus cause a double effect dangerous to the channel.

In the first place, the river current would then not be turned southward, and would throw down its deposits immediately in front of the piers instead of to to the south, as in 1861-62; and secondly, the banks thus formed, instead of being broken down by the gales and carried southwards, would be driven back on the channel, which they would still more choke. In the present year there have been no floods worthy of the name, and the current of the river has, consequently, been so feeble that the bank has formed between the heads of the piers, norrowing the entrance but not *barring* it. This bank is not disquieting, because being almost in the position of the old bar, and being distinctly traceable to the weakness of the current, there is not the slighest reason to doubt that the first strong flood will at once carry it away; the deep water being no farther off than in 1860, the littoral current is still there, so that the same causes for removing the bank existing, no one can doubt but that the same result will ensue. In fact, the entry at Sulina may be pronounced to be well in hand, for should any summer's survey show a decided advance of the coast line, it will always be in the power of the authorities charged to keep open the river, to extend the piers, and again reach the littoral current. No such prolongation seems at the present moment called for, and a comparison of this year's (1863) survey with that of 1857, shows that the 15 feet line is about where it then was, whilst the 18 feet line is now much nearer to the entry than in 1857.

There is then every reason to suppose that these works will continue to produce their effect for the time that they were originally intended to last, namely, for 5 or 6 years.

The fourth river alluded to as an example of the effect of piers, and the first that will be cited to throw light on the application of the canal system, is the Vistula, a river which indeed gives instruction on every kind of river works, whether in the channel or at the mouth.

Attempts were made to improve this river, as long ago as 1594, when rough piers were carried out, but it would seem without producing much effect, as the plan does not show more than 5½ feet. A subsequent map, bearing no date shows the piers of 1594 already absorbed in the advancing coast line.

The map of 1682, shows the Western Pier extended seaward and banks again forming behind it. A breach of the root of this pier through which the river cut itself a lateral communication with the gulf, 10 to 12 feet deep suggested the idea of obtaining a permanent channel independent of the mouth. The engineers of that day set to work to dredge the channel, throwing the stuff on the bank at the back of the pier, and thus aiding the natural deposit to form an island which became the right bank of a lateral canal leading from the river to the gulf.

The plan made in 1691, shows that this canal was then led into the gulf under a pier projected from this dredged island, and another of 1697, shows the canal shut off from the river by lock-gates, but shows, also, the difficulty of keeping open the canal, which was then only 7 ft. deep at one part and had a passage of 9 ft. only into the gulf.

In 1717, a further attempt was made to keep open the proper mouth by piers, which seems to have been abandoned, for a map shows that in 1724 a second pier was carried out at the entrance of the canal, the old pier prolonged, and the banks of the canal revetted; and as the canal itself was narrowed, its depth was doubtless increased, though no soundings are given.

In 1745 the Eastern Canal pier had been much extended into the gulf, but a depth of only 10 feet obtained. An extension of the pier at the mouth of the river had, at the same time, produced only 6 feet.

A subsequent map, records the apparent adandonment of all further attempt to open the mouth, and shows the successive prolongations of the canal piers, the western in 1775, 1796-97, 1802-03, the eastern in 1797, 1801, 1802, and 1802-5, which resulted in a depth of 13 feet in 1805.

A chart made in 1815, shows no extension of piers, but, as it gives no soundings, is of no value, except in showing the growth of buildings along the canal banks, and that the lock was solidly constructed in masonry.

The author was informed by the engineer who, in 1858, had charge of all the Prussian Harbor Works, that no efforts were available to keep open a greater depth than 10 feet into the canal before the year 1840. Each successive prolongation of the piers gave an additional depth up to 13 feet, but it was always immediately lost, and fell back to 10 feet. It was not till after the breaking through of another mouth several miles to the east, in 1840, as before mentioned, that the Prussian Engineers could congratulate themselves on having obtained a good entrance to the Port of Dantzic. As soon as that unlooked for, but fortunate, event took place, they commenced with praiseworthy activity to take advantage of a circumstance which had removed from the neighbourhood of the canal the continual deposit of sand which choked it. The river was at once shut off from its old course, by a dam through which vessels of small tonnage and rafts pass by means of lock-gates, on the sill of which there is a depth of 8 ft. The old mouth was cut off from the sea by a solid dam built across its channel; the old lock-gates, at the entrance to the lateral canal were removed, being no longer necessary, and the piers at the mouth of the canal were greatly extended.

By these means an excellent channel of 17 feet was obtained, and has since been maintained by constant dredging at the head of the east pier.

As already mentioned, the dredging is carried on under peculiarly favorable circumstances, as the Gulf of Dantzic is land-locked, and gives no rule for what could be done in the open sea.

The author has adduced the case of the Vistula as his last example of the effects of piers, and his first of the application of the canal system; but it is now time to examine why and how piers have failed—and how, if at all. the canal can be said to have succeded.

In the Gulf of Dantzic there can hardly be said to exist a littoral current. The littoral current of the Baltic, from west to east, passes along the Helas—the long low natural breakwater forming the Gulf of Dantzic—and strikes against the coast which then immediately tends to the north; the main force of the current is then carried northward, but a portion of it sets into the Gulf of Dantzic, from east to west from the point of contact, whilst a second current passing round the head of the Helas sweeps along the shore of the gulf, and traveling from west to east, meets the main current somewhere opposite the old mouth.

No more unfavourable circumstance for the opening of the river could be imagined.

The river issuing into slack water at the meeting of two currents threw down its deposits at once. The easterly current being, if anything, the stronger, these desposits were slightly carried to the west, just sufficiently to fill up the canal entrance. One cannot be surprised, therefore, at the failure of the Vistula piers.

As to the canal, it is not an example of the cutting a channel through a delta such as has been done at the mouth of the Ebro, and has been proposed for the Danube; a better channel having, by an accident, made its appearance behind one of the piers, advantage was taken of it, and an island formed outside of it.

Nevertheless, adroitly as this was done, persevering as were the efforts of the Dantzigers, for more than 150 years, to keep this channel open to sea-going vessels, it was not till the event of 1840, which removed the mouth so many miles to the eastward, that anything like success was obtained, and then only by employment of piers and by dredging.

Who shall say then, decidedly, that one system has failed and the other succeeded? Rather let it be said that engineers, taking advantage of nature's help, have used one system and the other, each in its measure, according as local circumstances directed, and that any attempt to lay down any one system, dogmatically, without reference to the locality, would assuredly fail.

The only instance in Europe of a river opened into a tideless sea, by means of a lateral canal, is the Ebro in Spain; but, here again, the experience gained does not allow the author to say that a decided success has been achieved, nor does the example bear on the general question, for the canal opened is so small that it will not admit sea-going vessels; and although nominally completed in the autumn of 1861, it had not been opened to general navigation in March, 1863.

This canal connects the Ebro with the Port of Alfaques, a small gulf formed by the delta of the Ebro to the south of the embouchure.

The length of the canal is 10,734 metres, its depth 2.70 metres, and its width 10 metres.

It leaves the Ebro at Amposta and passes through

two locks before arriving at the sea; at the first of these there is a fall of 1.50 metres, and at the second, which is in the Port of San Carlos, there is a fall of 2.20 metres. The canal is nourished by a smaller one, led out at Cherta, 29 kilometres above Amposta. This second canal also irrigates the Delta of the Ebro; its level, in the basin of Amposta, is 4 metres above the sea canal.

Ample means thus exist for flushing the channel and keeping the locks clear of deposit, which, nevertheless, forms to a considerable extent.

The sea entrance is led into the Gulf by dykes which direct the flushing, and thus increases its effect. From what has just been stated, it will be evident that this kind of canal would be applicable only where there is so rapid a fall in the river near its outfall as to give the required head of water within a reasonable distance. On the Danube, for instance, even if the canal would admit vessels frequenting that river, which it would not, no means exist for forming an alimentary canal furnishing the means of flushing.

When the river is low, and that generally happens when the navigation is most active, there is a difference of barely 3 feet in the level on a length of 50 miles; and the ground to be traversed by an alimentary canal is a swampy marsh intersected by lakes, through which a canal only could be led at a great expense. Again, then, let it be said, that local conditions must decide the choice of works; and though a canal, of dimensions sufficient for river craft, and fed by a canal at a high level, may have been opened on the Ebro, it affords no argument in favor of a similar work elsewhere, where the same conditions do not exist.

There can be no empiric cure for river bars; the remedy for the evil must be sought by patient study and examination of the locality where it exists, and founded on a consideration of all the disturbing causes, winds, currents, and quality of water, so different on different coasts and even at different points of the same coast.

Having now considered generally the causes that lead to the formation of bars across the mouths of rivers discharging their waters into tideless seas, and the systems of improvement that have been applied to certain rivers in Europe, the author will next proceed to give a detailed account of the works which have been carried out at the Sulina mouth of the Danube. It will, however, be necessary first to give a short sketch of the considerations other than technical, which are involved in the improvement of this river, which alone will account for works having been carried out in that branch of it which has been generally admitted to be the least suitable for navigation, and for the temporary character of those works.

Prior to the year 1829 the mouths of the Danube were held by the Turks, and it is said that under their direction every vessel leaving the river was obliged to tow a heavy rake to sea over the bar, so as to raise the sand, and let it be carried by the current away from the channel. It is even said that, in consequence of this treatment, there used to be a depth of 14 feet on the bar. These assertions are not worthy of much belief; no written record is in existence establishing their accuracy, and a strong reason exists for disbelieving them, which will be presently mentioned.

From 1829 till 1854 the Russians had possession of the Delta of the Danube, and in 1840, the navigable channel having become very shallow, the Austrian Government called upon Russia to take steps for improving it. A convention was signed, by which Russia engaged to keep a steam dredger employed in removing the sand which had encumbered the channel. This dredger worked but at rare intervals, and constant complaints were made against Russia for not keeping open the channel, which went so far as to accuse her of not only not trying to remove the obstacles, but of adding to them by sinking vessels in the channel. It was at this time that the condition of the river under the Turks was held up in contrast to its state under the Russians, and the power of the rake was so much insisted upon.

After the Crimean War, the free navigation of the Danube having formed one of the principle preliminaries of peace, a special arrangement for its proper administration was stipulated for in the Treaty of Paris, and the improvement of the mouths of the river was confided to a Commission, in which the Seven Powers who signed the treaty were represented, each by a delegate.

This commission, of which the author of this paper is the British member, entered upon its duties in November, 1856, and has ever since remained in office. Its principle duties were to free the mouths of the Danube from the obstacles that hindered their navigation. It may be mentioned here, that before the Russian occupation of the Danube, in 1829, the trade of that river was very insignificant. By the treaty of Adrianople, the Russians secured to the principalities a right which they had accorded to them during their occupation, of freely exporting their grain, which was previously a Turkish monopoly.

From this time the Danube trade went on gradually increasing, until the abolition of the English Corn Laws gave it a great impulse, as shown by the exports of 1847, which bounded up to more than 1,800,000 quarters from 1,200,000 quarters in 1846, and from 230,000 quarters only in 1837. Since 1847 the trade has steadily increased, excepting in the years affected by the Hungarian Rebellion and the Russian War.

One of the first cares of the Danube Commission was to seek for means of temporary improvement, whilst a proper study of the river was being made to ensure the proper application of permanent works. In the spring and summer of 1857, a full trial was given to the dredging and raking systems during a strong current, when, if ever, they should be successful.

A heavy iron harrow was towed over the bar from 50 to 80 times a day for two months, on as many days as the weather, which was generally fine, permitted; at the same time, a powerful steam dredger was at work in the channel, but their united efforts did not do more than increase the depth by about 6 inches, and when the flood current became weak even this much was lost, and the raking and dredging discontinued.

The rake only scratches up the bottom, but does not raise the mud and sand into the current. Near the bottom the current is feeble, and sometimes even running inwards, if, then, a rake passing 50 to 80 times in a day produced no effect, how could the vessels going to sea, which before 1829 did not number as many per month, deepen the channel 4 or 5 feet? One practical question, moreover, has never been answered, how did the rake get back again? For there were no tugs in those days, and the rake was too heavy for a boat to take on board or tow back. The intermittent working of a dredger in the open sea may be also set aside as unequal to the task of deepening a channel over a bar exposed to all the prevailing winds, for the channel dredged to-day is filled up by the swell of to-morrow, as the experience of 1857, at the mouth of the Sulina fully proved. In the course of 1857, surveys of the different branches of the Danube, forming its Delta, were made, and reports received by the commission from their own engineer, Mr. Hartley, an English civil engineer, and an engineer sent by the Russian Government, to aid their commissioner.

(To be continued.)

WATER SUPPLY FOR NEW ORLEANS.

REPORT OF CITY SURVEYOR.

SURVEYOR'S OFFICE, NEW ORLEANS, *November 14, 1876.*

To the Hon. Mayor and Administrators of the City of New Orleans:

GENTLEMEN.—I have examined and carefully considered the question of a full and permanent supply of suitable water for the City of New Orleans, and now have the honor to report the result of my investigations, and to transmit, herewith, for your information certain drawings and approximate estimates, etc., relating to the same.

There is no city in the Union of the size and importance of New Orleans where such an inefficient system exists, and perhaps none where the natural advantages are greater for having at all times and for all purposes, an abundant supply of the very best and purest water that could be desired.

The recent severe drought here of over two months' duration, and the inconveniences consequent upon the depletion of nearly all cisterns, together with the inefficiency of the present works, and the dangers imminent thereby from destructive fires, has directed public attention anew to the necessity of having a more reliable system of water supply, and furthermore, to have the subject at once agitated with a view of bringing about such a desirable result at the earliest practicable moment, consistent with the financial interests of the city.

There are two attainable sources from which New Orleans can be amply supplied, *viz.*: either by means of the Mississippi or the Tangipahoa rivers, and the object of this investigation has been to gather and submit for your consideration certain items regarding the relative advantages and disadvantages of each, so that the plan promising the greatest amount of good, may be entertained as the proper one for adoption.

The Mississippi river has the advantage of being in close proximity to the point of consumption, while the Tangipahoa has the disadvantage of being many miles distant. The Mississippi, on the contrary, has the disadvantage of being in a low basin and of a muddy nature, and will have to be clarified by means of costly structures before being rendered acceptable for use, and afterwards lifted at great and constant expense by powerful machinery; while the Tangipahoa has the advantage of being beautifully clear, and can be tapped at such an elevation that the water will flow of its own accord, and thus acquire no extra machinery or expense for raising it to the highest level established for consumption. The Mississippi would possess one considerable advantage in the use of forcing engines, and the facilities afforded thereby through a slight increase of power without much additional expense, in furnishing water to higher elevations at any time in the future when such an improvement may be required; whereas the Tangipahoa with a fixed source or head must remain always with a fixed capacity in that respect, and without any opportunity of increasing its force or power, except by great changes and much larger outlays. A considerable though remote disadvantage would exist in the long line of piping from the Tangipahoa, which would be subject to interruptions during invasions of an enemy, thus cutting off temporarily a supply of water; whereas, by the use of the Mississippi, all of the works would be concentrated within the limits of the city, and thus any such dangers would be obviated. The supply from the Mississippi would be almost unlimited, while that from the Tangipahoa, although comparatively limited, would yet be sufficient, without exhausting its full low water volume, to furnish abundantly a population of more than tenfold that which the city contains at present.

With the use of the Mississippi, it would be necessary not only to enlarge and remodel the entire old works at or near their present location, but also to construct at two other suitable points in the Third and Sixth Districts another set of new works similar in general design, so as to ensure an adequate supply of water for the entire City. This distribution from three separate locations would become expedient on account of the peculiar conformation of the inhabited portion of the City, in the disproportion of its width to its length, and the greater difficulties which would exist for supplying its elongated front of twelve miles, from the one point now established.

The improvement of the old works, and the construction of the new ones, should conform to a general plan, having for its object the furnishing of clear or settled water freely, to the same elevation as that which could be obtained from the Tangipahoa river, or at least to the third stories of all buildings within the city limits.

To accomplish these results, it will become necessary in the first place to provide for the construction of a requisite number of settling reservoirs. The Mississippi water in its natural state is too muddy for domestic uses, but after remaining in a condition of rest for several days, and the alluvial matter held in suspension is allowed to subside by certain appliances, it is susceptible of becoming as clear and wholesome as the inhabitants of any city could desire.

These settling reservoirs should be built in the ground by means of excavations as near the river bank as practicable, and to a depth of about fifteen feet below the natural surface. This would make the bottoms of the reservoirs about on a level with the surface water in the river at its lowest stage. The advantages of such an arrangement would be manifest in the facilities afforded for assisting in the filling of the reservoirs through self supplying pipes connecting with the river, during a large proportion of the year, when the surface of the water is at any of the points above its minimum or low-

est level. Whenever the water, however, is at any of the stages below that of flood height, the deficiency in filling the reservoirs through the pipes must be provided for by the agency of steam power, and to this end one or two pumping engines of light capacity will have to be located adjacent to the line of front compartments for that purpose. As the lowest stage of water in the river continues but a very short time in the year, it is evident that the maximum working power of these engines will only be called into requisition at long intervals and the expenses, therefore, of operating the machinery will be reduced to an average of what would be required between the extremes of high and low water or to about one-half of that which would be incurred by constant use.

After the water is clarified and becomes ready for use, it is intended that the pumping machinery shall take it from certain rear compartments at these reservoirs and force a supply directly to the main underground pipes as well as through them to a certain number of stand pipes, or small vertical reservoirs, so located and distributed throughout the city that they would answer the same purposes, at comparatively little cost, as one set of large elevated distributing reservoirs concentrated at each of the three points selected. On account of the flat surface, or plateau upon which New Orleans is situated, and the absence, therefore, of any suitable natural elevations, it becomes a question of enormous expenditure to construct reservoirs to a proper height for distributing purposes, as compared to the plan above suggested for receiving reservoirs on a lower level near the river bank. The same power which would be consumed in lifting the muddy water from the river to these elevated reservoirs, there to become settled, would suffice to supply the clarified water, with the aid of the stand pipes, directly to all the points of consumption. It is plain, therefore, that by this arrangement the expensive elevated reservoirs could be dispensed with, and a great saving or reduction thereby will be made in the total outlay for accomplishing the ends desired.

The construction of these reservoirs after the manner and plan proposed, is deemed the best and most economical that could be adopted to secure the benefits contemplated. The principal object to be obtained being the supply of clear or settled water, it is of the first importance to have the required quantities pass through the process of settling *before* it is touched by the main pumping engines, and certainly the cheapest mode of accomplishing this is through the construction of suitable basins for holding a sufficiency of water as near as possible to the natural surface, adjacent to the river bank or source of supply.

New Orleans is peculiarly fortunate in her topographical situation as compared with other large cities in the Mississippi Valley, for carrying out the conditions prescribed for a successful supply of river water. In the first place, all her buildings, or the third stories of the same are practically on the same plane above the standard low water level of the river, which would necessitate merely a minimum force of steam power to supply all buildings alike, and secondly, the river bank bears such a favorable relation to the river itself, on account of the slight differences between the extremes of rise and fall, that the cost of constructing and supplying the receiving reservoirs as designed, would also be reduced to a minimum figure. At St. Louis, Cincinnati, Louisville, Memphis and Vicksburg, owing to the elevated and uneven nature of the ground, a great disparity exists between the highest and lowest building sites, and this condition, taken in connection with the greater rise and fall in the river at those places, must necessarily cause a much larger outlay and expense in providing for and delivering the water to these additional and irregular heights.

There are difficulties not to be overlooked and which must be provided for, in the removal of the sedimentary deposits which would be from time to time collecting in these settling reservoirs. The accumulations cannot be completely disposed of by being washed back into the river, on account of the bottoms of the reservoirs being located too low to admit of this expedient, and the difficulties, therefore, must be dealt with in some other practical manner.

It is proposed to have suitable derrick arrangements to be attached to the several settling compartments and by some ingenious contrivance, the sedimentary matter can be scooped up and lifted the short distance to the surface, and thus easily deposited in carts to be hauled away. This material would be exceedingly valuable to the city for many years to come in filling up the many ugly holes over the river front, especially in the First District, and afterwards to property owners for filling up and raising low lots, thus utilizing that which might otherwise become a waste. In this way it is calculated that the removal of these sedimentary deposits, at stated intervals when required, would cause little or no expense to the city or upon those having control of the works.

In carrying out the plans herein proposed, there would be no actual necessity for using the old elevated reservoirs; but as they exist and cannot be put to any other beneficial use, it may be proper to maintain what is left of them in order to hold a surplus of water for fire purposes and as a substitute for one stand pipe for the District in which they are located.

It is calculated that the water works at their old location when remodeled and improved, would supply the city for all purposes between Canal street and Napoleon avenue. The other or new works to be located at some suitable points in the Third and Sixth Districts, should be duplicates as to machinery, reservoirs, etc., of the improved old ones, and these would supply respectively those portions of the city between Canal street and the Barracks, and between Napoleon avenue and the upper limits of Carrollton. The economy and advisability of this arrangement or distribution of the works, would consist principally in overcoming the difficulty of constructing all the reservoirs together of the total capacity required at one single point, on account of the large and valuable space to be occupied in the center or heart of the city; and, moreover, in the advantages to flow from having three separate and distinct sets of pumping engines so that in case of accident and delays to one, the others would measurably supply the deficiency and cause comparatively but slight interruptions in the delivery always of the maximum quantity of water.

The approximate estimate for cost of the improvements as above contemplated would be as follows, *viz.*

Constructing settling res'vrs at or near old site	$300,000
Light pumping engines for supplying same....	30,000
Additions and improvements to present large engines.....	15,000
Two stand pipes or vertical reservoirs.....	50,000
Expropriation of property required.....	20,000
Total for remodeling and enlarging old works.	$415,000
Constructing settling reservoirs in Third District.....	$300,000
Light pumping engines for supplying same...	30,000
Forcing or heavy pumping engines, machinery, etc.....	175,000
Three stand pipes or vertical reservoirs.....	75,000
Expropriation of property required.....	20,000
Total for new works in Third Dristrict.....	$600,000
Constructing settling reservoirs in Sixth District.....	$300,000
Light pumping engines for supplying same...	30,000
Forcing or heavy pumping engines, machinery, etc.....	175,000
Three stand pipes or vertical reservoirs.....	75,000
Expropriation of property required.....	10,000
Total for new works in Sixth District.....	$590,000

To these figures must be added $500,000 for the estimated cost of improving the old and laying additional pipes to accommodate the whole of the present inhabited portions of the city.

Total estimated cost of supplying the entire city of New Orleans with clarified water from the Mississippi river, *viz.*:

Enlargement and improvement of old works..	$415,000
Construction of new works in Third District..	600,000
Construction of new works in Sixth District..	590,000
Laying additional piping required.....	500,000
Total.....	$2,105,000

The Tangipahoa is a beautiful stream fed throughout by bountiful and never-failing springs of pure water, and passing for the most part through beds of clear gravel and white sand. It takes its source in the vicinity of Summit, Mississippi, a little more than one hundred miles from New Orleans, and after crossing the Louisiana State line, courses generally parallel to and a few miles distant to the eastward of the line of the N. O St. Louis & Chicago railroad, and finally empties into Lake Ponchartrain. The point selected at which it should be tapped is about five miles northeast of Tickfaw station, or opposite a point which is sixty-one miles from New Orleans, and one mile distant from the railroad. At this location a main retaining dam must be constructed with suitable wing levees, and so arranged that the water will be raised above its natural low water flow about fifteen feet, or sufficient to form a proper head for supplying the main *receiving* reservoir, which is designed to be constructed adjacent to the railroad at or about the fifty-six mile post. The connection between the receiving reservoir at the railroad and the dam on the river will be made by means of a canal with suitably embanked sides or walls, which will act as a conduit for the required quantity of water which is to be diverted by the dam from its natural flow or channel. This receiving reservoir should be constructed so as to cover about forty acres of ground and to hold at least ten days supply for the city.

When the water is raised in the river by the dam, as above proposed, its elevation will be about ninety feet above the ordinary street level of New Orleans, and this same elevation will be of course transferred and maintained in the receiving reservoir as a head or starting point for distribution through the iron piping leading therefrom into the city.

The volume of water passing in the river at its minimum or lowest stage has been calculated by recent measurements to be about one thousand cubic feet per second, or 648,000,000 standard gallons per day. This is deemed amply sufficient to furnish New Orleans with an abundant supply of water for all time to come, or for the largest population she can ever reasonably be expected to attain.

In connection with the dam, it will be necessary to construct a suitable lock, so as to regulate the influx of water during the freshet periods in the river, and to prevent that which would be discolored thereby, from reaching and contaminating the clear water already received in the reservoir. These interruptions would last at the utmost but a few days at a time, only during the prevalence of a rain storm, and within a few hours after its cessation the river would begin to subside and gradually become again perfectly clear, so that the maximum supply of water in the reservoir would be soon replaced and its normal condition regained before the occurrence of a second flood. It is for this reason, and to provide against such contingencies, that it would be necessary to construct the lock as proposed, and, also, to have the receiving reservoir built on the enlarged scale which has been designed.

The topography of the country and the character of the land is exceedingly favorable to the location, construction and maintenance of these several works, and a large proportion of the whole can be substantially executed by cheap earthen embankments, and therefore, only a small amount of expensive masonry will be required.

The cost of all these works combined is estimated approximately at $150,000.

From the main receiving reservoir to the city, it will require a line of iron piping to be laid alongside the railroad track, and for a total distance of about fifty-six miles. This piping should not be less than forty-eight inches in diameter, to answer the present demands of the city, and will cost at the rate of about forty thousand dollars per mile to be laid in position, or for the entire distance $2,240,000. It is calculated that this one line of piping will deliver about 12,000,000 gallons per day to the limit of the third stories of all buildings, or sufficient to supply the present daily wants of the city. At some future day whenever the population and demand for water increases, an additional line of piping can be placed alongside of the first one so as to enlarge the supply, and this, too, without increasing the capacity of any of the other works. The only physical obstacle which presents itself in the laying of the piping, is the crossing of about one hundred feet in width of the navigable opening in the railroad bridge at Pass Manchac, but this is not a difficulty which cannot be successfully overcome. If it were not for the existence of the railroad and the facilities afforded by it for getting the heavy piping in position, the Tangipahoa scheme would be impracticable, for there would be no way of overcoming the difficulties in crossing the intervening swamps, without first preparing a roadway at an

unwarrantable cost for transporting the different pieces to their destination.

It is proposed, also, as a matter of utility to establish at various points throughout the city, iron tanks or reservoirs of moderate capacity which may be termed stand pipes or vertical reservoirs, and each of which will be able to accumulate an additional column of water during the night or non-consuming portion of the twenty-four hours, sufficient to greatly accelerate the succeeding daily supply for that portion of the city contiguous to it, as well as to facilitate by proximity of pressure, the delivery of water to the highest practicable elevation.

We have, then, as an approximate estimate for the supply of water from the Tangipahoa river the following, *viz.*:

Construction of lock, dam, canal and res'vr,	$ 150,000
Iron piping 56 miles and laying same.....	2,240,000
Stand pipes or vertical reservoirs.	250,000
Expropriation, etc., of property required ...	25,000
Laying additional piping throughout city...	500,000
Total for whole.....	$3,165,000

Comparative estimates of original cost or first outlay for supplying New Orleans with a full and permanent supply of suitable water.

From the Mississippi River.....	$2,105,000
From the Tangipahoa River.....	3,165,000

I have not felt myself called upon in this communication to do more than present the facts and suggestions above recorded, without expressing an opinion, even in an engineering point of view, for the preference or adoption of one plan over the other, leaving this as well as the financial problem involved, and all details connected therewith to be discussed and decided by those who may be induced to co-operate with the city in the prosecution of the enterprise.

Respectfully submitted,

THOMAS S. HARDEE, *City Surveyor.*

NEW YORK UNDERGROUND RAILWAY

We take from the *City Record*, New York, the petition of successors of the New York City Central Underground Railway Company, asking for certain rights and privileges which is as follows:

To the Hon. Mayor and Board of Aldermen of the City of New York:

I most respectfully beg to ask, on behalf of myself and others, successors of the New York City Central Underground Railway Company, some temporary rights and privileges in streets and public places, as specified in the annexed schedule, in order to facilitate the work on the tunnels and railways which we are preparing to construct and operate. These facilities you are by the third section of chapter 230 of the laws of 1868, empowered to grant, and they will aid in establishing what has become the greatest public necessity as well as the most important improvement ever proposed for this or any other metropolis, not in the cost or magnitude of the work, but in view of its location and public advantages.

This is the construction of a railway out of sight and hearing, passing through the most densely occupied portions of the city, extending from the Battery to Eighty-second street and Madison avenue on the east side, with a branch from Union square under Broadway to the Circle at the southeast corner of Central Park. These lines will constitute the southern section of the Great Metropolitan Railway, extending over eight miles, with double tracks throughout, one mile more than twice the distance from the City Hall to Forty-second street, and can now be made complete at a cost covering all lands to be purchased and compensations to be made, under $7,750,000, and with scarcely a doubt for $7,000,000.

If $1,250,000 were added, as has been alleged was necessary for equipments, at the present price of locomotives and cars, over two miles—one-fourth of the whole length—would be compactly covered with rolling stock, too excessive for use. But equipped for 200,000 passengers per day, or over 60,000,000 per annum, so as be carried at a maximum speed of from 35 to 45 miles an hour, these great arteries of metropolitan communication, through the length and breadth of the population and to the core of business, will cost not more than $9,000,000, and less than you were recently informed would be required for the section from City Hall to Forty-second street, not half as long, and that can never give one-third the accommodation. The actual estimate of the cost of that section made by Mr. Buckhout for Mr. Vanderbilt in 1872, was not half the amount reported to you by Commissioner Campbell, although embracing $1,000,000 for purchasing land in that portion of the line running through the blocks from the Bowery to Centre street.

However important rapid transit may be for the four and a half million passengers who last year arrived at and departed from the Grand Central Depot, it is of at least ten times greater consequence to the community residing north of Forty-second street, and south of Ninetieth street, who will use this extension and branch, and who now give over forty-five millions of passengers annually to unsatisfactory appliances for conveyance. Stopping at Forty-second street, the great residential districts would be merely touched, but not provided with rapid transit, while these two limbs to the body of our work will make it a complete metropolitan improvement.

There will be three stations on Madison avenue north of the Grand Central Depot, and three on Broadway, north of Madison square, and an experience of fourteen years in London has demonstrated with absolute certainty that each one of these stations will supply as many passengers to the line as the Forty second street station, and probably more. There are several horse railroads where each half mile up-town receives and distributes more passengers than come and go to that station from the lower part of the city, and who count certainly not more than three millions in a year, the others coming and going from hotels and private residences up-town.

Now, rapid transit is wanted for the people of the City of New York, and not for strangers to get here; but if, for the latter when here, and these lines will afford complete facilities to the whole district between Third and Eight avenues, which supplies annually about one hundred millions of passengers to horse cars and omnibuses, showing the forty-five or fifty millions estimated for the whole line to be moderate, and yet ten times more than a country railroad can give.

Transporting city passengers by steam has for fourteen years been done in London in precisely the way that we are preparing to do it, the only way that is possible, and that has made it known to mankind. This is accomplished there with a speed, facility, and economy as much superior to horse-power, as steam is here superior to horses for conveyance in the country; but London has only about half the travel per square mile as is here.

Moreover, we now know that the capital for this whole work can be obtained with greater certainty and on better terms than for the section from the City Hall to Forty-second street, for the percentage of income will be much greater on the whole investment than for any section or part. The net earnings, after deducting every possible charge, will be not less than one million five hundred thousand dollars per annum, or seven per cent. on twenty millions of capital, over twice the amount required, and, to the shameful incapacity of this city, as we shall see, this has been demonstrated for years in London.

The extension under Madison avenue, for two miles north of Forty-second street, will pay on every rod of the line, and, in addition, it will have the very great value that, where the New York and Harlem Railroad will give one passenger down to the City Hall, this extension will give over two and probably three passengers more. Up to Ninetieth street, about the limit of dense occupancy on the east side, there will be as complete command of city traffic as if the New York and Harlem Railroad had no existence. No one is likely to go to the Fourth avenue for rapid transit on a broken line, when he can have it without break or transfer down to the extreme southern end of the city. The single neighborhood around the Forty-third Street Station will give more business than the Grand Central Depot.

Similar considerations, not to be disregarded, urge the construction of the branch on the west side, for, as we have seen, it must have an immense traffic. Together, they will give rapid transit to a population that now sustains certainly four, if not five, lines of horse cars, and three lines of omnibuses, which have a far larger capital, and incur four times the operating expenses. Experience has shown for a dozen years in London, that the work will be done incomparably better than by all these existing and costly appliances, and with three-fold greater profits.

Such is the economy of steam over animal power, that the most profitable steam railway would at once become bankrupt, if horses were substituted; a train drawn by a powerful locomotive, costing less to move than an omnibus or horse car. And so great is the concentration of city travel, averaging two hundred and fifty times more per mile on one horse than on the steam railroads of the State, and notwithstanding the great expense of animal power, the Third Avenue Railroad yet earns seven per cent. on the capital of $1,250,000. If these passengers were drawn by steam, it is demonstrated in London, as well as on our country steam roads, that the net income would be 7 per cent. on a capital of $3,000,000 per mile. The underground railway there, although charged with four, five, six, and on the last mile down town, as high as seven millions of dollars per mile for right of way, earns over 4½ per cent. on the whole capital, showing the enormous profits where no land is bought, and the great value of our right of way under streets, not to be had but in short pieces in London, and where, often, in getting to these, the extra cost is about as great as if they were abandoned. The approaches to the East river bridge show how great would be the expense of buying the way here, and the Fourth avenue tracks, if through private property, would have cost seventeen, instead of six millions, illustrating these charges in London. Even the land for, and for approaching the new Bergen tunnel, one part consisting of rock and the other of swamp and mud, unoccupied, has cost more than that great work itself.

By going to the Battery, all from every quarter up-town can reach Wall street by the Wall street station, giving renewed vitality to that national centre of business, and a greater value to extreme down-town property than has been known in the history of the city.

The work which you can thus aid, is not, therefore, to desolate the inside for barren outside districts, but it is for the benefit of the whole of the now paralized property, business, and population of the city of New York, for imparting new life and power from one end of the city to the other, so that it can expand into and over these now waste places, and sustain the burden of its great taxation.

Only since last October, after the legal transfer was perfected, has there been opportunity for capital to approach this great metropolitan improvement, because those controlling it, for the seven years before it came into our possession, were interested to secure its defeat, unless by mortgages for fabulous amounts and other devices, counter corrupt inducements could be presented for its progress. With these and gross exaggerations of cost, studied misrepresentations of practicability, and for suppressing all knowledge of the enormous profits, has the work been so long delayed. The same persons seduced credulous capitalists to waste some two millions in worthless rapid transit devices for no other object than to prevent this. The public has been slow to recognize these causes that have defeated rapid transit, but they are as veritable as the frauds of the ring.

The prostration of all other underground lines, by preserving and yet not using this grant, came from the fact, that it occupied all practicable routes between Third and Eighth avenues, Broadway, south of City Hall and north of Union square, and Fourth avenue, from Eighth to Fourteenth street.

In curving the line in and out of Fourth avenue, a competing line would be driven for such a distance under the blocks on the east side, as to add at least another million for land, besides the similar charge from the Bowery to Centre street. This was the real difficulty with the Vanderbilt grant which Mr. Buckhout, in his plans and estimates, tried at first to disregard. It was at least one of the causes, and probably the real cause of its abandonment. At the same time the Beach or Broadway charter was worthless as long as this was in its way. Capable of the greatest public benefits, our rights and franchises could yet be used to perpetuate existing evils, and to this they were dedicated by the previous managers, from whom they could be recovered only by long and persistently pursued legal proceedings. When this recovery was foreseen as inevitable, but before it occurred, some of the directors became a majority of Major Wickham's rapid transit commission, and the public will remember, kept that body in secret session under lock and key during its whole existence; and this is the local history of rapid transit.

Not three months since, this work might have been restricted to a mere extension of a country railroad to the City Hall as a concession for the capital to carry it out. But the necessity for this paralyzing limitation has now disappeared, and how fortunate for the future growth and grandeur of the city, the public can as yet hardly form a conception.

These arteries, throbbing with the life of the city, will be the first realization of the grand metropolis which is to emerge out of the load of debt and taxation, which makes recovery under existing conditions impossible. For any future but that of death, this city must be utterly different, vastly greater and more powerful than ever before, a result not of municipal charters or political tinkering, but of that mastery over material conditions which makes the distinction between barbarism and civilization, between the stone and iron age, between the era of animal and the era of steam power.

This new force on land and water, outside of and all around Manhattan Island, has overtasked its feeble motors, for there is a daily exaction of labor from that poor mechanical insect, the horse, such as is not found elsewhere on the earth.

The remedy is the work in which we are engaged, and it is now as certain to be made, as that we are not to relapse into barbarism. All that has been required for the last ten years, in order to have rapid transit, was to learn how it was to be had, there having been nothing in the way but the want of this understanding, and the conspiracy got up to maintain it.

With this combination broken, there are no serious difficulties to overcome, for capital cannot be kept away when the barriers so carefully erected and so long guarded, for preventing its approach, are removed. This is now substantially accomplished, for after years of effort to that end, this great gift of the right of way under streets, worth from two to three millions sterling if in London, is now available for use, and we entertain no doubt whatever of having, within a reasonable period, the work in a state of active construction.

But no one man, or ten, can do this without aid—the most potent controller of railroads never made even one; and, if the people of this city are to have a great metropolis they must share in the means and efforts for its attainment, which they will cheerfully do; and here is the first opportunity in this matter that has been presented. Very respectfully, your obd't servant,

O. VANDENBURGH.

Dated May 19, 1877, 229 Broadway, N. Y.

Schedule of Privileges in Streets and Public Places

for Constructing the Underground Railway asked for by the Successors of the New York City Central Underground Railway Company.

1. To deposit materials outside and south of the line of the works near the Staten Island Ferry, on the Battery.

2. Similar privileges on the north side of the street, between the Post Office and the City Hall Park, reserving sufficient width of roadway for vehicles to pass each other through the whole length of the street.

3. Similar privileges at the junction of Worth, Baxter and Park streets, with a like reservation of passage.

Similar privileges on the northerly and southerly borders of Union square, on ground outside the square and not within the boundaries of streets.

5. The same privileges at the Circle, southwest corner of Central Park, and in streets crossing and near Madison avenue, where no houses are erected on the lots abutting against the streets where the materials are deposited.

These privileges to be revokable by the Mayor and Board of Aldermen, and subject to regulation by the Commissioner of Public Works.

O. VANDENBURGH.

Which was referred to the Committee on Railroads.

TIDAL WAVES ON THE LAKES.

The Cleveland *Herald*, in connection with the tidal wave reported from Port Stanley, Ont., gives the following interesting information :—

Tidal waves on the lakes are not of uncommon occurrence. In fact they occur on all lakes and seas, without visible cause. Two or three years ago Col. Chas. Whittlesey, who had given the subject much attention and collected a large amount of information concerning it, read before the American Association at Hartford a paper containing detailed accounts of such tidal waves or "swashes" on this chain of lakes as had been noticed and recorded.

The first noted on Lake Superior was in 1789, when Alexander Mackenzie saw at the Grand Portage, on the north shore, opposite Port Royal, a sudden fall of water, equal to four feet, which soon returned with a rush and continued to vibrate several hours. In 1834, the water above the Sault suddenly fell two and one-half feet, and in half an hour came surging back with great velocity. In 1842 the same thing happened below the falls the current of the river rushing swiftly up stream. Dr. Foster has placed on record that in August, 1845, whilst in an open boat on Lake Superior, between Copper harbor and Eagle River, he saw a huge wave, twenty feet high, suddenly rise in the lake, about a quarter of a mile distance, which curled over like an immense surge, crested with foam, and swept toward the shore, diminishing as it advanced. It passed the voyagers without doing them an injury, was succeeded by two or three swells, and after spending its force on the shore the lake resumed its calm. In 1847 and the two following years Dr. Foster observed similar phenomena. A sudden rise of one foot three inches was observed at Copper harbor in November 1851. In July, 1855, there was a succession of rises and falls at the Sault from nine in the morning to four in the afternoon, the maximum of variation being two feet two inches At Superior City, on the 22nd of September, 1865, there was an oscillation of fifty inches in fifteen minutes.

On Lake Michigan Father Andre reported in 1670 there was on Green Bay a sudden change of three feet in the level of the lake, which left his canoe high and dry. In April, 1858, a wave rushed into the river from the lake with such violence that the ferry boat on the Menominee was upset. There was a sudden ebb, and in about twenty minutes two larger waves came and receded. The difference in about three quarters of an hour was full six feet.

Tidal waves on Lake Erie have been numerous and violent. It is supposed that the loss of Col. Bradstreet's expedition off Rockport river, in October, 1761, was due to a sudden "swash" similar to one observed at the same place by Mr. Taylor in 1811, when a white crested wave rushed in from the calm lake and carried a barrel of salt several rods over what had been dry ground into a ravine. DeWitt Clinton reported that on the 10th of May, 1823, at Otter creek, on the Canada shore of Lake Erie, when the water was calm, a wave nine feet high swept over the beach into the woods and stranded a thirty-five ton schooner. The same thing occurred at Kettle creek, twenty miles distant. In the spring of 1830 Mr. Luther Winchell, of Lake county, was fishing with three others at Madison dock, when three large waves came rolling in and swept the party inshore. The first wave was fifteen to twenty feet high, and the succeeding ones of diminishing height. Fourteen years later a wave fifteen feet high swept into Euclid creek, carrying everything before it. On the 19th of November, 1845, the water registers of Colonel Stockton, at Cleveland, showed a sudden fall of two feet eight inches. In December, 1856 the level of the water at Toledo changed in a few hours ten feet, first rising five feet above the ordinary level, and then falling five feet. In this case, however, the oscillations followed a change in direction of a strong wind.

With the last mentioned exception none of the sudden changes of level were accompanied by or followed strong winds. In nearly every case the sudden rise or fall of water occurred when the air was still and the lake perfectly calm. In many of the cases, especially those of oscillation, the "swashes" were followed by storms. This fact, which is true of similar oscillations of level in large bodies of water in other parts of the world, suggests a possible explanation of the phenomena. The tidal wave is said to come in from open water parallel to the shore. May it not be caused by a sudden atmospheric disturbance, or wave, which is local in its extent? This merely a suggestion, for scientists who have given time and study to the matter commit themselves to no definite theory.

THE WILKES-BARRE MEETING OF THE INSTITUTE OF MINING ENGINEERS.

The American Institute of Mining Engineers has held this week in Wilkes-Barre its sixth annual meeting. Organized in the same place in 1871 by a small gathering of twenty-two, its numbers have now increased to seven hundred, and its usefulness and influence are felt not only throughout this country, but also in Europe. Many interesting and valuable papers were presented at the meeting, some on subjects which have not hitherto been brought before the Institute, as Mr. Bowie's paper on Hydraulic Mining in California, and Mr. Keith's paper on the Transmission of Power by Electricity. The accession to the membership was thirty-five. The local committee arranged an admirable programme of excursions, whereby the interesting features of the Wyoming Valley above and below ground were shown to the members under the guidance of Messrs. Mercur and Stearns. The officers elected are as follows:

President, Dr. T. Sterry Hunt, Boston; Vice Presidents, Thomas Eggleston, New York; John B. Pearse, Boston; W. P. Shinn, Pittsburg; Managers, E.T. Cox, Indianapolis; H. S. Drinker, Philadelphia; A. L. Holly, New York; Treasurer, Theodore T. Rand, Philadelphia; Secretary, Thomas M. Brown, Easton, Pa.—*The Engineering and Mining Journal.*

CORRESPONDENCE.

BEAVER CROSSING, SEWARD CO., NEB., *May 21, 1877.*

Editor ENGINEERING NEWS.

SIR — Will you please inform me of the legal manner of establishing a lost section corner? If one person on a section desires to have the section surveyed, can he oblige those cornering with him to help pay for the survey? Does a county surveyor's work out of his own county amount to anything in law?

G. A. K., *County Surveyor.*

To establish a lost section corner, the east and west, and north and south section lines must be chained between the two nearest undoubted corner posts; divide these measurements *pro rata* with the Government distances given on the plat and establish the missing corners therefrom.

We understand that in some states, by giving due notice according to law, the parties whose lands have a common corner or boundary, are obliged to share the expense of the survey. We think this is the law of Indiana, but we do not know positively whether it is or not. It is a difficult matter, however, to compel adjoining owners to share the expense of a survey; there is always one party who, feeling certain that he has a little more than his own, will refuse to do anything to assist in the location of boundaries. It depends in what State the county surveyor may be practicing whether he can make legal surveys in counties outside of his own. In Illinois his survey is legal in any part of the State if he can prove himself to be a "competent" surveyor; if he can satisfy the owners of adjacent lands between which he runs a line in any county in America, his survey is legal by their mutual agreement.

NEW ORLEANS, *May 23, 1877.*

Editor ENGINEERING NEWS:

SIR.—In your issue of May 19th, there appeared a letter from W. H. Bell, C. E., which criticised somewhat intemperately the re-publication in your journal of an article formerly prepared by me on the drainage of New Orleans.

As Mr. Bell has felt himself professionally aggrieved and has indulged in some insinuations and reflections considered unjust to me, I feel compelled to submit a brief statement of facts in reply.

In the first place, the recent publication of the article with accompanying map in your paper was made through the instrumentality of my successor, Mr. D' Hemecourt, the present City Surveyor, or one of his assistants, who delivered the map plate, which was city property, to your editor on his request, while recently in New Orleans, and was not accomplished through any agency of my own.

The original publication in the *Sanitarian* was brought about through the instrumentality of the then president of the Board of Health here (Dr. White), who had received from the editor a request for a description of the drainage of New Orleans, and at the earnest and repeated solicitations of Dr. White the article in question was prepared.

I did not feel myself called upon to do more than to describe the situation as it existed, as the accredited engineering officer of the city, and not to eulogize Mr. Bell or any one of the many other local civil engineers who had previously participated in maturing and recommending the plan of drainage which had been adopted. I certainly did not take any credit to myself in the article for being the projector of the system, or for having performed any special services in connection therewith, and as a refutation of any charge in this direction, I would simply state that the pronouns *I* or *my* cannot be found once in the entire article. My principal aim and object was to make a plain recital of facts for those who had solicited the information, with such other suggestions relating to the subject as I thought would be of interest to the general public.

As to the attempted satirical remark of Mr. Bell in reference to my being a "map copyist," and the charge that I had plagiarized from the plan prepared by him, I assert that my drawing was in every respect an original one, designed from the same public data possessed by him, with many more details embodied upon it, differing in every respect that it is possible for any two things to differ, prepared by different persons on the same subject.

Mr. Bell states also in a spirit of disparagement, that my connection with the drainage of the city under *his* system was only for seven months, but with due deference to his accuracy as an engineer, it will be well for him to refresh his memory, and he will be compelled to acknowledge his error, that from the time of my accession to office as his successor, in December 1874 to the month of July 1876, when the work was suspended, there is an aggregate of nineteen instead of seven months.

I have written this only to defend myself against the imputation of professional discourtesy, and until I am convinced that the failure to unduly eulogize is a breach of professional etiquette, I have nothing to regret in the publications which have been made under my name with regard to the topography and drainage of New Orleans.

Very truly,

THOMAS S. HARDEE, C. E.

BOOK NOTICE.

The Forces of Nature. Part 1: A popular Introduction to the study of Physical Phenomena, by Amedee Guillemin; translated from the French by Mrs. Norman Lockyer, and edited with additions and notes by J. Norman Lockyer, F. R. S. Illustrated by nearly Five Hundred Engravings. London and New York: Macmillan & Co. 1877.

PROSPECTUS.—The "Forces of Nature" has hitherto been accessible in England only in an expensive edition in one large volume. It appears to the publishers that by issuing it in monthly parts, at about half the original cost, they will bring it within the reach of a wider circle. They believe it is not too much to say that there is no work in the language from which the general reader can obtain a clearer view of the principles of physical science, and that it is as sound and accurate as it is popular. The number and beauty of the illustrations, and the lucidity of the style, have given it an enormous circulation in France, and two very large editions have been sold in England. The whole book has been thoroughly edited and adapted for the English public by Mr. J. Norman Lockyer, F. R. S., whose name is a guarantee not only for the scientific accuracy, but for the completeness and lateness of the information.

The first of the seven books of which it consists treats of Gravity and Attraction, the weight of air and gases, the pendulum, the balance, and the barometer. The second discusses the phenomena of Sound, propagation of sound in air and tubes, and the theory and explanation of musical instruments. The third of the laws of Light and Color, phosphorescence, double refraction, diffraction, and polarisation. The fourth book is devoted to Heat. The fifth and sixth to Magnetism and Electricity, and the seventh disscusses the rainbow, the rise and fall of clouds and fog, and the whole subject of Atmospheric Meteors. There is a very complete and elaborate index to the work.

The First Part will be issued on May 1, and the publication will be continued Monthly, the whole being completed in Eighteen Parts.

The *Daily News* says:—"The method of pictorial illustration, accompanied as it is by descriptions of singular clearness, makes the experiments as easy to understand as though they were actually performed before the reader. There are 450 of these illustrations, all well executed, and so admirably fitted to the text as to make the book interesting to young people, while it is at the same time worthy of the notice of the student."

The *Saturday Review* remarks:—"Altogether the work may be said to have no parallel either in point of fulness or attraction, as a popular manual of physical science."

It is with genuine satisfaction that we introduce to our readers this valuable and interesting work. The prospectus, which we give in full, tells the story, and we can say that, judging from the very popular style in which this first part is written,—so free from mathematical formulæ, and so simple, that it must recommend itself to every observer of the laws of nature, and especially so to a large portion of the readers of this journal, who, while they have perhaps been accustomed to studying physical science with the aid of the higher mathematics, are yet not averse to reviewing the same truths

in a popular form when presented by such a master as J. Norman Lockyer. The pages are seven by ten inches in size, the typographical execution is exceedingly fine, and, being very profusely illustrated, the book when complete will be an acquisition of genuine value to the library of any student. The parts are 40 cents each, and for sale by Hadley & Bros., of Chicago.

PUBLICATIONS RECEIVED.

Zeitschrift des Architekten-und I genieur-Vereins zu Hannover. Hanover. 1877.

Experiments and Observations on the Emission of Heat by Hot Water Pipes. By William Anderson, M. Inst. C. E. Transactions Institution of Civil Engineers.

NOTES.

The question of water supply is rising in Owen Sound, Ont.

The Norwalk Shoe Factory will do a business of over $100,000 this year.

Large beds of fire clay and block coal are being developed in Ellsworth, Mahoning County, O.

The Keystone Bridge Company has made a bid for a bridge to be erected at Cleveland. The structure will cost about $80,000.

The Swedes are building gun-boats for Russia in sections so that they can be readily transported to a distance and quickly screwed together.

Recent incorporations in Ohio, with their capital stock: Security Lightning Rod Co., Canton, $100,000: Quaker Mill Co., Ravenna, $25,000; Alliance Co-operative Association, $350,000.

A new stone arch county bridge at Centre Valley (Lehigh county?) lately fell down. The structure was 130 feet long and 30 feet high—cause of falling, faulty construction.

Joseph G. Kirk, civil engineer, has been appointed to the position of Corporation Engineer for the town of Guelph, Ont., at a salary of $800. Mr. Kirk is an old resident of Stratford.

The officers of the Missouri Valley Bridge Co., at Leavenworth, Kansas, are Mr. E. J. Farnsworth, President; Mr. D. E. Eaves, Secretary and Treasurer; and Mr. H. A. Wise, Engineer.

The mines down the Ohio valley are rushing out coal beyond the capacity of the C. & M. R. R. company to carry. At Vienna junction there were 150 cars at a time nearly every day last week.

The Baldwin Locomotive Works, Philadelphia, have just closed a contract for 19 locomotives for Brazil. Fourteen of these are for the Dom Pedro II. railway, and five are for a narrow gauge road.

The grading for the additional tracks to the Pittsburgh, Cincinnati & St. Louis R. R., from Ogden avenue, Chicago, to the Stock Yards, has been let to John McAffery, of Brighton, Ill; masonry and timber work to the Chicago Dredging and Dock Company, and the Iron superstructure for two bridges to the Detroit Bridge and Iron Co., of Detroit, Mich.

A Ledge has been discovered in Lincoln, R. I., within two miles of the village, which promises to be of great value. An essay of some of the quartz shows that a ton contains 1456 pounds of lead, 64 ounces of silver, and 40 pennyweights of gold. The specimens that have been taken from it, are said to be by far the richest in metals of any ever found in New England.

May 22nd, Gov. Robinson of New York vetoed the items in the Supply Bill appropriating money for building eleven iron bridges out of the canal fund; also for repairs for the Cheeming Crooked Lake, Chenango, and Black River Canals, "for the reason that the work is not absolutely necessary, and the canal revenues are not likely to be sufficient to warrant the doing of any work that can safely be dispensed with."

Heavy rains in the West have caused a rise in all the rivers tributary to the Missouri and Kansas, causing serious interruption of railroad traffic and damage to the lines. A large area of country is liable to inundation if the river banks give way. As it is the rise of the waters is greater at Lawrence than has been known for twenty years. The recent warm spell in the West has melted a great deal of snow on the upper watersheds of the rivers, and this, with the heavy and continuous rains, has contributed to swell the floods pouring down into the low, flat valleys approaching the Mississippi River.

A cable dispatch from London announces the death of Matthew Digby Wyatt, the well known English architect. Mr. Wyatt was born in 1820 near Devises, his father being a police magistrate. At sixteen years of age he entered the office of his brother, Thomas Henry Wyatt, architect, and in the same year he gained a prize for an essay from the Architectural Society. Some years later he went to the Continent, where he studied the principle art monuments of France, Germany and Italy. In conjunction with Mr. Jones and Mr. Wild he greatly assisted in the settlement of the plan of the great Exhibition Building in Hyde Park in 1850. He was the author of a great number of important works on architecture. In 1855 he received the Legion of Honor.

Our citizens who can look back with a shudder at the inexpressibly filthy condition of the streets of Chicago the close of the past winter will doubtless take a deep interest in the process by which the London thoroughfares are kept clean all the year round. When one thinks of the topography of our city, and the way in which nature but asks the smallest assistance to keep the surface clean, he is filled with indignation to think how incompletely even that little aid is given. London, with its seven thousand miles of streets, rained on twelve months of the year, traversed day and night by tens of thousands of heavy vehicles, and trodden by its nigh four millions of people, yet manages to scoop up its mud daily over the entire surface, removes all its ashes and garbage with clock-like regularity, and so keeps down the death-rate even in the most densely populated districts to a surprisingly low figure. We can do the same and, proportionately, with a tithe of the same effort. It is a mere matter of business, and susceptible of the same economic treatment as the sweepings of a tobacco factory, where nothing goes to waste. Fortunes are made by doing the work in London.

The sub-committee of the Stock Exchange, appointed to secure reports from railroad and other corporations whose securities are quoted on the list, have made a report of the result of their labors, which is only encouraging from the probability that it will rouse stockholders to a proper sense of their rights and duties. It says the coal railroad companies excused themselves from reporting more than once a year, on the ground that being miners as well as carriers they could not tell where they stood oftener than once a year. The President of the New Jersey Central gave them clearly to understand that he would give no more information than the law obliged him to give, and said the public was satisfied with his reports, a belief which subsequent events rudely disturbed. The Michigan Central reported manfully while the returns were favorable, but no longer. The Milwaukee & St. Paul did the same thing. The Northwestern & Rock Island were absolutely uncivil in their replies. The Committee say they were discouraged a good deal by all this, but still more when they found that some reports, even when "signed and sanctioned by men of wealth and reputation," were often utterly untrustworthy. They therefore felt in no humor to make any report at all, but say that events have since occurred, meaning the tumble of stocks, which have gone far to accomplish the desired end. The fact is that concealment about the condition of corpo ations can have only one object—namely, the aiding of speculators, who are too often the directors themselves, either in getting rid of their shares before their real value is known, or borrowing money on them at a valuation much above their intrinsic worth. Both these things are forms of fraud, and of atrocious fraud when committed by trustees; and it is high time that it was stopped by stringent legislation, and the breed of autocratic, secretive, speculatiing cozening presidents and directors brought down to their proper place as holders of important trusts both for the public and individuals, and made to reveal the results of their administration as regularly and as fully and comprehensively as if they were accounting for the outlay of a sum of money given them for specifieu objects.—*N. Y. Nation.*

RAILROAD NOTES.

The Evansville, Owensboro & Nashville R. R., Ky., was sold to the bondholders on May, 29, for $60,000.

The P. D. & L. H. Railway Company Ontario., commenced repairing the harbor and building coal docks at Port Dover.

The Kansas Central Narrow-Gauge R. R. will be extended shortly from its present terminus, Nolton. The contract for building twenty-five miles will soon be let, and the work rapidly pushed forward.

General Superintendent Clark, of the Union Pacific, states positively that they will build one hundred miles of road towards the Black Hills this summer. The point from which the road will start is yet undesided; it will be either Sidney or Cheyenne.

The completed section of the Emlenton & Shippenville R. R., from Emlenton, Pa., to Edenburg, is reported as doing a very large business. A contract has been let for an extension from Edenburg west to Clarion, about 15 miles, the work to be finished by Sept. 1.

On the Hamilton & Northwestern Railway, between Georgetown and Barrie, Ont., there are employed at present nine hundred and ninety-two men, two hundred and sixteen teams, and sixty-one cars. The work on this division is being pushed forward with great vigor.

The remaining mile of track on the Dayton & Southeastern road, between Xenia, O., and Dayton, has been laid and the rest of the track put in good order, and on May 18 the first through train ran from Dayton to Washington Court House, 47½ miles. Regular trains will run hereafter.

The Canada Southern R. R. Company is building a grain elevator at the St. Clair river terminus of its St. Clair terminus, twelve miles below Lake Huron and Sarnia, which is to be completed by September. When completed the Commercial line of propellers will run between Chicago and this terminus, giving a favorable lake-and-rail-route.

Tracklaying on the Rochester & State Line R. R. was resumed at Pearl Creek, N. Y., May 7. Track reached Wyoming village on the 11th, and is progressing rapidly toward Warsaw, and will reach that place shortly. The road will be open for traffic to Warsaw June 15, and to Gainsville, 53 miles from Rochester, by Aug. 1.

There is talk of some action being taken in reference to building the proposed narrow gauge railroad from St. Louis Mo., to Colorado. A meeting is about to be called to effect an organization for the purpose of building a road. An enterprise that promises so much for St. Louis and the territory along the route, and which can be so easily put through, should be begun without further delay.

The last act of the long litigation concerning the title to the Kentucky Central R. R. took place in Covington, Ky., May 15, when the stockholders of the old Covington & Lexington Company met and voted to accept and ratify the compromise of 1875, which settled the once apparently endless suit of the Covington and Lexington Company against the Bowler heirs. The vote cast was 21,533 shares for accepting the compromise to 443 against it.

About one hundred men have arrived from Quebec, Canada, to work on the extension of the Quebec Central Railway through Garthy, and more are expected. A Quebec paper asserts that the company have decided to connect with the Grand Trunk Railway somewhere above Point Levis, while another says that a prominent capitalist of that city has agreed to advance the money required to connect with the Levis & Kennebec Railway at Ste. Marie de la Beauce. Five thousand tons of rails have been bought for the road by Messrs. Reed Bros., and will be shipped early this month on very advantageous terms.

Arrangements have been completed by the Chicago, Burlington & Quincy R. R. Company for building their extension in Chicago. The work consists substantially of widening the present grade so as to admit of two extra tracks being laid along side those at present existing, the new tracks only diverging sufficiently to allow of the swinging clear of the new bridges over the river and canal, which the present addition necessitates. The work commences at the point of junction of the Pittsburgh, Cincinnati and St. Louis R. R. with the North-Western, at Ogden avenue, and runs south to the Stock Yards junction with the P. C. & St. Louis R. R. The grade will be the same height as the present one; the piers of the bridges are to be built of stone masonry, with iron superstructure. According to present anticipations the work will be completed ready for use by the fall of the present year.

A French engineer has proposed to establish tramways with granite tracks in lieu of rails, in Finisterre. He is of the opinion that this system is far preferable to the ordinary railroads. There already exists a vast network of what are in truth tramways with granite rails, worked by horse traction, in Northern Italy. In the streets of the principal towns, and sometimes on the roads, tracks of granite are laid in the highways. The surface of these tracks being flat and perfectly smooth, the wheeels of the vehicles glide over them with the least possible friction. The conductor of each vehicle takes care so to guide it that the wheels always remain on the granite. The author of the project maintains that there is nothing to prevent the granite lines from being used by carriages driven by steam power, in like manner as though drawn by horses. At the same time it is not proposed to adopt the train system on granite tracks; each carriage will be provided with its own steam power, will move by itself, and be guided by means of a mechanism specially devised for the purpose.

The Aurora, Ill., *Beacon* says that the Chicago, Burlington & Quincy Company requires all material of whatever kind, to stand a thorough practical and scientific test before being delivered to the locomotive car or track depots. All boiler material is tested by bending while cold, which it must do without showing a flaw, and by getting the tensile strength of every sheet. Every sheet of iron for fire-box use must stand a tensile strain of 60,000 lbs. per sq. in. Every sheet of boiler material not for fire-box use, must stand a strain of 55,000 lbs. per sq. in. Every sheet of steel for fire-box use must stand a tensile strain of 70,000 lbs. per sq. in., and no sheets of iron can be issued from the store without being marked "Tested, O. K." All stay-bolt iron must stand 60,000 lbs. per sq. in., and bend double cold without showing any flaw, and a bolt ¾ in. in diameter must bend double cold, with a thread cut on it, without showing cracks more than ⅓ of an inch in depth. All common bar iron, whether round or flat, must bend double cold without showing a flaw deeper than ⅓ in., and bend double red hot without showing any tendency to "red shortness." All flues or boiler tubes must be of maker's weight, not less than No. 13 (wire gauge) in thickness, nor greater than No. 11; must caulk into a flue sheet without cracking or showing any seams in iron; must flat down and bend double cold without showing any flaw or crack either across or lengthwise of flue, and must show a homogeneous material when subjected to an acid bath.

THE SCIENCE OF ROAD MAKING.

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

[THE AUTHOR'S ADDITIONS TO THE ORIGINAL ESSAY ARE SET IN SOLID TYPE.]

INTRODUCTION.

An apology and explanation from the writer to the readers of this reprint would seem to be proper, showing the reason why he has allowed this Essay to be re-printed, with only a few notes in the way of additions, rather than enlarge and entirely re-write the whole. He was conscious of its many short-comings at the time it was first written in 1870, in the evenings of some twenty-five or thirty days. Subsequent experience as Superintendent of streets in two towns, and as a Civil Engineer, has, of course, only served to increase this feeling; and at one time it was his intention to use this Essay as the mere starting point for the composition of a little treatise on the Art of Road Making, for the use of Engineers and others, and considerable material was gathered together for that purpose. But other business intervened then; and now, when the publisher of ENGINEERING NEWS having signified his intention of re-printing the Essay, the writer finds that all the time that he can devote to writing on Engineering subjects is so fully taken up, that he cannot undertake to revise, remodel, and enlarge this essay as he would like. But rather than do nothing at all, he has added a few notes, which, it is hoped, may not prove unwelcome to the readers of this Essay, and of ENGINEERING NEWS.

This treatise was written in answer to the printed circular of a Committee of the Board of Agriculture calling for "treatises upon the science of road-making, and the best methods of superintending the construction and repair of public roads in this Commonwealth."

This circular was issued about the middle of December, and as the time for writing and sending in the called for essays was limited to January 28, the writer has thought it best, no specific character being prescribed for the treatises, to attempt to write one suitable to be so called from the stand point of the *public*, rather than from that of the Civil Engineer, and, giving results rather than the methods of arriving at them, to be as concise as possible.

THE SCIENCE OF ROAD MAKING.

Starting, then, with the first of the two subjects mentioned in the circular,—the science of road making, we can divide this into three periods: 1. Laying out a road; 2. making the road-bed, which includes all earthworks, cutting and filling, culverts, drains, bridges, even tunnels, etc.; and 3. the making of the road surface; to which, not improperly might be added, 4. keeping the road in repair.

LAYING OUT A ROAD.

The considerations which determine the best location of a road, are those arising from the nature of the travel it is proposed to accommodate; that is, from the admissible grades, radii of curves, etc. Given two points it is desired to connect, with no intermediate point where the road is to touch, that route is the best which will cost least to build and maintain, the grades and curves being kept within bounds; and to find this location constitutes the whole problem of the engineer.

In older countries, where trade and manufactures are more settled and unchanging than in the United States, the probable future travel upon a road about to be laid out and built, forms a material element in the data that govern its alignment and grades. A very able and clever article upon this subject may be found in the Journal of the Society of Civil Engineers and Architects at Hanover," for the year 1869, and also in pamphlet form. It is in the German language, written by Launhardt, Superintendent of Highways (and a civil engineer) in the Hannoverian provinces.

The Romans built all of their roads in perfectly straight lines, up hill and down, at a very great expense, as being absolutely the shortest distance between two points. At a later period in history, it was argued that a road *must* be winding to be agreeable, and many were so built only for this reason. The modern road-builder or engineer in general, ignores any such considerations, and has for his aim only to achieve the most, at the least present and future expense.

As regards curves in roads in a hilly or mountainous district, we have then the rules never to make a smaller radius than 20 feet, and that only in extraordinary cases. On roads where long logging or other wagons may be expected, the smallest radius ought to be 50 or 60 feet; and, in general, 40–45 feet is none too much.

A rule sometimes followed in constructing mountain roads, is, where the inclination is 1 or 2 in a hundred,† heavy teams require 40′ and light ones 30′ radius; with a grade of 2 or 3 in a hundred, heavy teams require 65′ and light ones 50′ radius. Where a reverse curve [shaped like the the letter S] occurs, there should be a straight piece connecting the two curves [Fig. 1.] On the contrary, where the two curve to be connected are concave in the same direction, the connecting link should be curved also, and not straight. [Fig. 2.] On the length of the curves the grade should be made easier than on the parts of the road immediately adjoining.

Fig. 1.

Fig. 2.

As regards grades, to start with mountain paths, we find pedestrians able to walk up an inclination of 100 in 120; mules, ponies, etc, 100 in 173. For roads, Telford's rule was, that for horses attached to ordinary vehicles to trot up a hill rising 3 in 100, was equal to walking up one of a 5 in a 100 grade.

Experiments have shown that—

1. On a road falling 2 in a hundred, vehicles would run down of themselves.

2. On the same kind of road, but having an inclination of 4 in a hundred, light vehicles had to be held back lightly, loaded ones with considerable force.

3. On a road having a fall of 5½ in a hundred, light vehicles had to be held back with considerable force, or if a brake was applied they had to be pulled, whereas heavy or loaded vehicles had to be braked to keep the horses from being speedily exhausted.

On inclinations steeper than 5 in a hundred, the rainwater running down the road is apt to do some damage to the road surface.

The regulations of different countries having a long experience in road building, such as France, Prussia, Baden, etc., vary somewhat, but the following is the general result:

In treating of roads, it often renders the subject much clearer, to divide them into three classes: first, second and third class roads, or, as we might also say, state, county and town roads. Accepting this nomenclature, we have this: for first-class or state roads, the greatest inclination should not exceed 3–5 in a hundred; second-class or county roads, 5–7 in a hundred; third-class or town roads, 7–10 in a hundred. A road rising 10 in a hundred is not supposed to have any heavy teams upon it. In ascending a hill it is well and proper to decrease the grade as the top is reached, and in the same measure as the horses get tired. Thus, if a first-class road starts up hill with agrade of 4½ per hundred, it shouldgradually diminish to 4 and 3½ in a hundred, and end near the topwith a grade of 3 in a hundred.

Launhardt, the superintendent of highways, and engineer, mentioned in the previous note has a valuable article on the subject of the best grades for highways, in the Engineering journal there mentioned, for the year 1867; re-printed also in pamphlet form. He shows in this article that, according to the received formula that expresses the relations between the tractive force, the velocity in feet per second, and the daily working hours that go to produce the maximum amount of work that can be got out of a draught-horse, a uniform grade between any two points, except perhaps in curves, and, if desired, for resting places, is the grade that tends to enable the horse or other-draught animal to produce the most work per diem.

If a grade of 4 or 5 in a hundred must needs be kept up for some distance, then it is well to have resting places 40 or 50 feet long, having a grade of only 1½ or two in a hundred, in the line of the road at proper intervals. An expedient adopted by Telford, the eminent English engineer, in order to avoid making a piece of road a mile long, on a less grade than 5 in a hundred, on account of the increased cost this would have occasioned, and yet not have this part of the road too much more tiresome for the horses than the rest, was to make the road-surface on this mile of a much better quality than on the remainder; the additional cost required for the improved road-bed amounting to only about one-half of what it would have cost to reduce the grade to say 4 in a hundred, as will be again referred to under the head of trackways. In sharp curves the grade should be only 1 or 2 in a hundred or level.

To be continued.

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

† In describing grades, the first figure gives the vertical height which is ascended in a horizontal distance given by the second figure. Both figures must of course be taken to refer to the same unit of length thus: 100 feet in 120 feet, 100 inches in 120 inches, or 100 miles in 120 miles, all express the same inclination to a level plane, and are more general in their application than the ways of expressing grades in so many inches to the foot, or feet in one mile, etc., etc.

ELEVATION OF THE OUTER RAIL ON CURVES.

We have noticed with pleasure the comparison of opinions by the roadmasters of the Atlantic & Great Western Railroad, upon the subject which stands at the head of this article, at their last meeting in October, 1876. The chief engineer, Mr. Chas. Latimer, has established the excellent practice of calling together, annually, the subordinates of the engineering department, for a conference and discussion upon various points of importance with reference to proper maintenance of the permanent way. The system which he has marked out cannot fail to secure an excellent road, well and economically kept up.

The practice in regard to the super-elevation of the outer rail on curves is very various; on some roads no rule seems to be applied, or, if the application of one is attempted the elevation is guessed at by the eye, without the use of a level. If the track-men are ignorant of the degree of a curve, and do not know how to find it by measurement of a middle ordinate, any rule is useless. Some roads elevate proportionately to the degree of the curve; some raise the outer rail less in proportion for a sharper curve, and on different lines the elevations range from one-half to one and one-half inches per degree, with a greater elevation on lighter curves.

If it is intended to just balance the centrifugal force by elevating the outer rail, the practice would be reduced to uniformity as soon as the speed was the same. But as freight trains at fifteen miles per hour, and express trains at from forty to sixty miles per hour, develop an amount of centrifugal force varying as the square of the velocity, there is a difficulty in deciding what speed to assume as a datum. Henck's Field-Book states that the usual practice is to adopt the highest customary speed of passenger trains, and his formula is:—

Elevation in feet equals gauge in feet multiplied by the square of velocity in feet per second and divided by 32.2 times the radius in feet.

This formula is then modified so as to contain the velocity in miles per hour and the degree of the curve.

The formula stated to be used in England by the best authorities is the same in a little more convenient shape, namely—Gauge in feet multiplied by square of velocity in miles per hour divided by radius in feet,—this multiplied by four-fifths will give the elevation in inches. If Bogie trucks are not used an additional cant of 7,200 divided by the radius in feet should be added to the above.

Mr. Latimer has adopted the rule for the Atlantic & Great Western Railroad, of elevating the outer rail ¾ inch per degree for those parts of the line where the gauge is 6 feet, and ½ inch per degree for the gauge of 4 ft. 9¼ inches, the speed being taken at thirty-five miles per hour. This is intended as an average between fifty miles per hour for passenger trains and fifteen miles for freight trains, and the results are somewhat less than those obtained by the above quoted formulæ. Mr. Latimer argues as follows in regard to his own road:—

"With such disparity of speed, and with but one track, it becomes of vital importance to decide upon the question of elevation in its bearings upon the points both of economy and safety. Upon a road having heavy grades and curves, the question is a more serious one than that on those of level grades and similar curves. As the freight trains are from three to five times as numerous as the passenger trains, it is important that the elevation of the outer rail should be calculated somewhat in consideration of their speed. If the elevation is made for the full measure of the highest speed of passenger trains, which run only one-fourth as often as the freight, may we not have it so great that the freights will be in danger of running off on the inside of the curve? Again, since the elevation of the outer rail has a tendency to retard the progress of the train, may we not, by using too much elevation, cause such a diminution in the power of the engine as to shorten up the train and haul fewer cars? This is not only theoretically but practically the case, and, should the elevations be made for forty-five miles per hour instead of thirty-five, it would probably cause a dropping of a car in each train, and result in the loss of at least one train per day. It is, therefore, essential to consider whether it is not wise to equalize the elevation, so as to avoid, as far as possible, the danger from too great an elevation for the low speed of freight trains and the two slight elevation for passenger trains."

After an immunity from such accidents as can be ascribed to want of proper elevation, comes the comparative wear of the outer and inner rails on curves as a good test of any rule for elevation. On few roads, we surmise, is careful note taken of this fact. The roadmasters of the A. & G. W. R. R. agree that the curves, when put up by their rule, wear in about the same way as on a straight line, though more in amount, and that the inside and outside rails wear evenly. One man excepts curves at the foot of grades where trains run very fast; there he finds most wear on the outside rail. Of course, in such locations, an increase of what is considered average speed will obviate the difficulty and, indeed, Mr. Latimer cautions his men to rather exceed a little the standard elevation than to fall below it. The introduction of speed gauges on many of the trains has had an excellent effect in preventing excessive speed at some points, and in producing an economical rate of working.

Careful observations and discussions on such points as the one we have referred to to-day, if generally instituted on lines of railroad among the officials of the engineering staff, would go far towards the establishment of uniformity of practice and towards settling many things in regard to which facts are of more utility than further theorizing.

THERE seems to be a disposition manifesting itself among railroad men in favor of larger car wheels, it being proposed to substitute 42-inch wheels in place of the present 33-inch ones. There has been no absolute reason for the adoption of the present standard diameter rather than another. A small wheel enables the centre of gravity of the car to be kept low; they cost decidedly less than larger wheels, and weigh less. The cost of a 42-inch wheel is put at a little more than three times that of an ordinary chilled, cast-iron wheel, and its weight will be about 800 pounds. The centre of gravity of our present cars can undoubtedly be kept at about the same height, even if the diameter of the wheel is increased nine inches. The *National Car Builder* sums up the advantages of the larger wheels, as claimed by their advocates, as follows: "In moving a given distance, or at a given rate of speed, the number of revolutions is 21 per cent. less than that made by 33-inch wheels, and with a correspondingly diminished friction of journals and bearings; there is a saving of fuel resulting from a decrease of motive power consequent on diminished friction; the brasses wear longer and less lubrication is required; the bearing surface of the wheel upon the rail is materially increased; the average mileage is 2½ times as much as that of the standard 33-inch wheel; the annual renewals are less, and cars are less frequently off duty for that purpose; there are no hot boxes; the cars have an easier motion and are more comfortable for passengers; the wheels are stronger and safer, can carry heavier loads in proportion to dead weight of car, while at the same time there is considerable saving in maintenance of way."

ON THE MOUTHS OF THE DANUBE, AND THE IMPROVEMENT OF THE MOUTHS OF RIVERS IN NON-TIDAL SEAS.*

BY MAJOR STOKES, R. E.

(*Continued from page 143.*)

A strongly pronounced division of opinion ensued, the majority of the commission desiring to improve the southern channel called the St. George, according to the project of Mr. Hartley, the minority aiming at the improvement of the Sulina, the central and smallest branch, upon the recommendation of the Prussian engineer, M. Nobiling.

The researches of Mr. Hartley had established that of the three branches traversing the upper part of the Delta, the Northern or Kiliah branch contains 17-27ths of the volume of the river, the St. George's, or southern branch, contains 8-27ths, and the Sulina 2-27ths of it. The current of the river varies from one knot to three knots an hour; it has been known to be as high as four knots an hour, but that was for a very short time; the usual current is from one-and-half to two knots.

On two points unanimity of opinion existed, namely, in the rejection of the Kiliah branch, which discharging by five different mouths forming a minor delta, offered no hope of success; and in the adoption of the parallel pier system, as best adapted to the local conditions of the coast.

As unanimity of opinion was necessary, the points in dispute, after a discussion of five months, were referred to the governments, and by a portion of them submitted to the examination of another commission.

During the delay that seemed inevitable, the Danube Commission considered it advisable to give a temporary relief to the navigation by opening a passage through the bar at the mouth of the Sulina.

With this object it called upon Mr. Hartley to give a project for works to obtain an additional depth of two feet for a space of five or six years, that could be rapidly constructed at a cost repayable by the navigation in the interval likely to elapse before the permanent works should be open to trade.

This sum was estimated at about £40,000, and a project for that amount was submitted by the engineer and approved, the engineer stating, however, that he did not think it likely any appreciable improvement would be obtained with the limited extension given to the piers which he recommended, but that with an expenditure of £80,000, he believed that success would be almost certain.

He proposed to construct his piers of cribs filled with stones, and connected with strong piling. In the absence of any experience of works on the coast, and in view of the frequent bad weather, Mr. Hartley thought that this system could be carried out with more rapidity, with fewer obstructions from bad weather, and at less cost than any other.

Experience did not justify his predictions, but his skill speedily turned that experience to account, and produced a work that has more than answered the original intention. It was decided to construct the north pier first, as the prevailing winds blowing from the north, the south pier could then be carried out under the lee of the other. In April, 1858, the first piles were driven, and no difficulty was experienced in advancing rapidly in the shallow water. At the end of May the first crib was sunk in seven feet of water, at 900 feet from the root of the pier. This crib was formed of beams laid horizontally, and dove-tailed into one another at the angles, the cohesion of the structure being ensured by iron bolts and oak trenails passing through the beams and holding them together. The floor was fixed at two feet above the bottom of the sides, that these might settle down into the sands. The crib was successfully sunk, and filled and surrounded with stones; the following day as it was found to be sinking unequally, timbers were added to bring the upper surface above the water, and more stone thrown in, till it seemed firmly bedded in its proper position. On the 6th of June a heavy gale came on, and a heavy sea beat on to the crib which was exposed at some distance in advance of the piling; on the 8th the crib was seen to be slowly rising, and at length fairly floated away. As soon as the storm ceased it was recovered, and examination showed that the workmen had neglected to bolt the timbers together as directed, the sides only having risen, leaving the floor weighted down by the mass of stone. This, the only failure in the whole course of the works, is mentioned here as it led to the construction of cribs of a more solid description; the horizontal beams are tied and bolted together by bolts through them, and straps round them, while the frame is still further strengthened by cross beams through every second layer projecting beyond the sides, and again bolted and strapped together. On the 4th of October, a crib of this description, 30 feet long by 15 feet wide, and 14½ feet high, was sunk in 8½ feet of water, at 1,710 feet from the root of the pier, and up to this crib the skeleton piling was carried before the winter. This crib was successfully floated into position, and rapidly filled with stones and sunk; it was surrounded on the same day by 100 tons of large stones to protect it against the scour of the river current. During the four following days the weather was too stormy to admit of more stone being deposited, and in this interval the scour caused it to sink unequally at the four angles from 2 ft. 9 in. to 5 ft., or on an average 4 ft. On the fifth day a further 150 tons of stone was thrown down, and the crib was built up to the intended level of the pier. After finding its bed it never changed or sunk further, and most successfully resisted all the storms of the winter, acting as a buttress against which the waves broke, and thus so well protecting the unfinished skeleton piling, that no injury was sustained by the latter during the many months that elapsed before work could be resumed.

The piling was carried out as follows:—

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*A Paper read at Chatham, England, October 16th, 1863.

Stage piles were driven from a light flat bottomed barge on which a ringing engine with a 5-cwt. monkey was fixed. On every available fine day the stage piles were driven on the line of the pier, keeping 100 feet or so ahead of the work; these stage piles were connected by cross planks on which rested the staging, whence the gauge piles were driven by a crab engine and 15-cwt, monkey. The gauge piles, in three parallel rows, of which the two outer were 14 feet apart, were driven at intervals of 7½ feet from centre to centre, and were tied together at their heads longitudinally by oak walings, 12 in. × 6 in., inside and out, bolted through and through, and transversely by cross stays 15 ft. × 12 in. × 4 in.; upon these transverse beams rested a roadway of pine planks, and an iron tramway for transport of materials. The gauge piles were of pine, obtained from the Carpathian mountains, in fine masts 80 feet long, and 2½ feet in diameter at the butt end. The sheet piles were at first of hornbeam, but subsequently of oak, as the hornbeam proved a very indifferent wood for water-works. The outer ends of the pier were constructed entirely of oak, of which fine straight piles 35 ft. × 1 ft. × 1 ft., were obtained from the forests of the Save.

The original project was to fill in the outer and inner line of gauge piles with sheet piling, and to fill the intervening space with stone, throwing down stone outside of each line of sheet piling at the angle it might take from the water line, to protect the foot of the piling from scour by the river current on the inside, and by the beat of the waves on the outside.

In the countries bordering the Danube, great difficulties were encountered in executing works, from the fact that no great works had been carried on there by the present generation, there were, therefore, no good artizans or even common laborers worth the name. Such contractors as were to be found based all their calculations on making enormous profits and fraudulent deliveries. Workmen unaccustomed to regular and fair payment, demanded a higher rate of wages than their labor was worth; the commonest was not to be had under half-a-crown a day, for less than half the work a good English workman would do. The Sulina works have produced quite a revolution in this respect, instead of having to bring workmen from Hungary and Transylvania, as in 1858, the Commission Works are now sought by more men than can be employed, who are ready to do a fair day's work for fair wages, because they have learnt that they are regularly paid to the day, and to the last penny due to them, and that to remain in employment they *must* do the work. The author has no hesitation in saying that the superintendence of English engineers and foremen has brought about this satisfactory state of things.

At first, however, great delay and many difficulties arose from the failures of the stone contractors to deliver stone of the size and quality required in the time stipulated; it thus frequently happened that the piling was far in advance of the stonework, and great scour consequently took place, leading to a far greater consumption of stone than was intended. Only the outer or seaward line of gauge piles was therefore sheeted at first, and stone thrown in to protect it.

During the first winter, which gave the structure a severe testing, the works stood thus: 1,390 feet of the pier were sheeted and protected by stone within and without to the level of the water, from thence to the crib the gauge piling was unprotected for 320 feet. The heavy break of the sea was in a great measure warded off by the crib, but nevertheless there was a considerable attack upon the remainder of the pier; this stood the assault so well that it was resolved to modify the original plan of the piling, and to sheet only the outer line, leaving the stone to take its slope from the water level on that line. The feet of the inner row of gauge piles were thus protected from all injurious scour from the river current, and it has been found that, although near the end of the pier, the stone goes down every winter, it is only packed closer down upon the sheet piling by the beat of the waves, and thus each successive filling in, in the spring, is adding to the strength of the pier at but a small expense.

The year 1858 gave a further experience, namely, that to give the cribs the necessary strength, their price became much enhanced, whilst the expected rapidity of construction to be obtained from them was not realised, on account of the difficulty of getting them safely into position, and filled with stone, before rough weather came on. The irregularity of the stone supply naturally contributed to increase this difficulty, but even had stone been abundant cribs could not have been sunk with the rapidity anticipated, nor could workmen have been found to build them; moreover, it was found that the piling proceeded with a rapidity beyond the most sanguine expectations, and was limited only by the insufficient supply of stone; it was only when the weather was very bad indeed that the pile engines could not go on with their work. It must be borne in mind that the absence of tides was an important advantage to this system. The cribs proved highly successful as bulwarks against winter storms, but as they were neither economical nor expeditious, their use was given up after the sinking of a second crib in the spring of 1859, and every effort was bestowed on getting forward the piling as quickly as possible; to this end great efforts were made to increase the supply of stone, every block thrown in was brought 50 miles in barges from the Toultcha quarries, which were of hard blue limestone "grauwacke," and a quickly pulverizing schist. It was found necessary to forbid altogether the supply of this latter, as it was not able to resist the roll of the sea, but the contractors naturally preferred to work it, as the most easy.

In the course of 1859, the frequent failure of the contractors enabled the commission to withdraw the supply of stone from them, and the quarrying was then carried on under the direction of their own *employees*, with the double advantage of obtaining the stone at a far less price, and in the quantities required. No serious difficulties were encountered from want of stone after the spring of 1860, by which time the working of the quarries was put on a proper footing. In the autumn of 1859, the north pier had been nearly carried to the extent of the project adopted. As no solution of the St. George's question then seemed probable for some time, and the possibility of finishing the second project without prejudice to the permanent works became apparent, it was resolved to continue the works to the extent of the second project, and the north pier was, therefore, continued without doing more to the south pier than to run out a portion of its guage piles, and to protect them with four feet of stone, in the hope that the slack water to the east would silt up, and thus a large outlay on sheet piling and stone would be saved; a hope that was fully realized.

In the spring of 1860, the good effect of the north pier became apparent in an increase of 4 feet to the depth of the channel. By the month of July, that pier was finished to its full length of 4,380 feet; but the want of the south pier to maintain the increased depth became manifest, and this pier was pushed forward with great rapidity. The weather was generally fine, and as the works were under the lee of the north pier, the swell from the more frequent northerly breezes was not felt, and the very great advance of 1,020 feet was made during the months of August and September—of which 830 feet were carried forward in the month of August—so that by the end of the year the effect of the south pier was already perceptible in an increased depth, which in the spring of 1861 reached 16 feet, on a good broad channel from which it has never gone back, though at times it has been as much as 17½ feet.

In the spring of 1859, an Italian vessel, new, and built of oak, was wrecked in mid-channel of the intended direction of the piers. After several fruitless efforts, by native divers, to get a charge below her keel, a diving dress of Heinke's pattern was purchased, which has been found most useful; by means of it, successive charges were lodged under this wreck, during the years 1860–61, and she was thus completely destroyed to a depth of 18 feet.

In the autumn of 1860, it was decided to extend the piers beyond the length projected, and they were completed to the lengths, respectively, of 4,640 feet in the north pier, and 3,000 feet in the south pier, during the spring and summer of 1861. The north pier has been sheeted (both inside and outside) on lines of gauge piles for 40 feet, and the interior filled in with stone. The stone footing, seaward, has been formed of the largest blocks of stone that could be obtained, and every year its base widens by the subsidence of the stone which is constantly thrown in to keep it at the level of the water.

Taking the whole length of the pier, this subsidence is very inconsiderable. After the storms of last winter 1,600 cubic yards of stone sufficed to make good the sinking. At certain points in the length of the north pier, the sea was observed to break with more violence than at others; these portions were, therefore, strengthened by enclosing a solid block of 30 or 40 feet of pier with sheet piling and filling it in with stone. At certain intervals, too, the space between the inner and outer piles was sheeted to check the enfilading roll of the heavy seas as they curled round the pier-head, and the displacement of the inner pile of stones was thus prevented.

At the head of the north pier a small timber light-house was built on piles driven through, and forming part of the "musoir," in which a light is kept during all but the winter months, when the pier becomes a solid mass of ice, which cuts off the light-house from assured communication.

The immense weight of ice thus heaped upon the pier has, up to the present time, never seriously damaged it. The head of the south pier is formed of a large crib which presents a solid mass on which the waves break harmlessly; it is, of course, well protected with stone.

The mode of construction and the changes introduced from time to time both in it, and in the extent of the piers, having been now explained, a general idea will be given of their direction, and of the gradual growth of the channel produced by them.

The north pier is a continuation of the left bank of the river. It is 4,640 feet in length, and is carried out to what was the 16-foot line before the works were begun in 1858. The pier runs east for 2,250 feet; thence it curves slightly to the north for 1,550 feet, on a radius of 6,000 feet; and the remaining 840 feet of its length runs E. by N. ½ N.

The south pier springs from the lip, forming the right bank of the river, at a point due south of the 1,900th foot of the north pier, which it approaches on a curve of 2,400 feet radius, for 2,400 feet, when it arrives at a point 600 feet from the north pier, to which it then runs parallel for 600 feet, leaving the latter to project 650 feet beyond it.

By the autumn of 1859, the north pier had attained a length of 2,700 feet protected by stone, the timber work being some 300 feet further out.

The south pier had, by that time, been carried out only in frame work without sheet piling or stone for 1,300 feet, and, therefore, exercised no effect on the current. At this stage of the works, the theory of an Austrian engineer, Mr. Wex, that only one pier was needed to remove the bar, seemed about to receive confirmation; for, in the spring of 1860, there was a narrow channel of 15 feet, and a good broad channel of 14 feet deep.

The spring and summer floods of 1860, however, quickly dispelled any illusion on this subject; for although the north pier had become 4,500 feet long by the beginning of August in that year, and the south pier, in skeleton, had reached the deep water, the old bar had speedily reformed in its old position, and there was a channel of barely 8½ feet. The object of carrying out the north pier first had been to gain shelter for the works on the south pier against the swell raised by the prevailing wind. As the north pier was now nearly at its full length it was decided to fill in and extend the south pier energetically; and by the end of 1860, this had been so well done that the timber frame-work had a length of 2,700 feet, of which 2,350 feet were solid, with the exception of 450 feet near the root, left open as above stated for the escape of flood waters.

The effect of the south pier became apparent as soon as it reached the channel; at the end of September, 1860, when it began to take a direction parallel to the north pier, the depth had increased to 9½ feet, in November to 11½ feet, and by the end of the year to 13 feet.

The early spring floods, which were in 1861 of unusual violence, gave a channel of 16 feet, which reached 17½ feet when the piers attained completion in the month of August, 1861.

Piling is used outside both the inner and outer gauge piles; these are oak piles which have been driven since

the completion of the piers to increase their strength and durability, and to prevent any ill effects that might arise from the gauge piles of pine perishing.

The advantages possessed by these works may be stated as:—

1. Their fitness for the object sought, as proved by their success.

2. The rapidity with which they can be extended to remove any serious shallowing of the channel.

3. Their cheapness; their section having been found to be amply sufficient to resist, not only the shocks of the sea, but very heavy collisions with vessels which have been driven upon them, and yet their first cost has only been £10 a foot forward in 16 feet of water.

It may be interesting to those who have accompanied the author thus far in this subject, to know what works have been proposed for the permanent improvement of this fine river.

The narrow and shoal channel of the Sulina above the lower 18 miles of its course, and the broad deep channel of the St. George throughout its whole length, together with the greater depth and more rapid slope of the sea bottom in front of its embouchure, have not allowed engineers and sailors to hesitate between the two rivers; they have declared unanimously in favor of the St. George, which would long ago have been opened but for the political considerations which were involved in it at first, and which, always resting professedly on engineering and financial reasons, have of late been strengthened by a division of opinion upon the system of works to be carried out.

The Commission of Engineers appointed to examine the technical question, whilst entirely in favor of opening the St. George, pronounced in favor of a lateral canal, leading from a point above its mouth into the sea to the north of the embouchure.

The opinion of those acquainted with the localities founded upon the examples, cited in the first part of this paper, is entirely opposed to the formation of the canal, and a long suspension of the permanent works has, consequently, taken place. It is probable, however, that a decision will before long be arrived at upon this subject.

ADDENDA.

GALATZ, *June 23, 1864.*

With reference to the concluding remarks on the effect of piers at the Sulina entry in the former part of the preceding paper, the author is desirous to give the experience gained during the last nine months, which is instructive.

In his paper (concluded and revised in September, 1863), he mentioned the absence of floods in 1863, and the consequent feebleness of the current, which had given rise to the formation of a bank in a position where it was not expected, but whence it would be easily removed by the first floods.

The correctness of this anticipation has been proved this spring. As 1863 advanced, the river became lower and lower, the current ever feebler, till it barely reached a quarter of a knot per hour. The bank between the pier heads grew up to within 14 feet of the zero level, except in a very narrow channel; but to sea-ward of the north pier, there was no filling up. In March of this year the river began to rise, and the current to increase.

The effect on the entry was immediate, and in less than a month there was again a navigable channel of 15 feet deep, which by the first week in May was increased to 15½ on a width of 150 feet, and the shoal of 13 feet, on a length of 700 feet, reduced to one of 14 feet on a length of 150 feet.

This large slice of shoal was not taken off to be deposited again in front of the piers, for the 15 and 18 feet lines are still where they were. The surveys of 15th of February, 1st April, and 6th May show the improvement due to the current, and how little deposit has formed outside, although the waters have for the last two months been thick with alluvial matter.

The floods, although considerable, have not exceeded an average height, and therefore the current has rarely exceeded, and not often reached, two knots an hour at the mouth; otherwise a greater depth would doubtless have been obtained.

The experience of the last three years has shown, that any bank formed outside is speedily broken down by the waves in the frequent gales from the N. E., and their substance carried away southwards by the littoral current; whereas, a shoal arising from the feebleness of the current at the point where the parallelism of the piers ceases, being under shelter of the north pier, and therefore not exposed to the break of the sea and the littoral current from the north, does not get removed till a flood comes down.

This being the case, Sir Charles Hartley has suggested that it would be better to prolong the south pier so as to push out any such bank beyond the shelter of the north pier, that it may be attacked and broken up by the breakers in northerly gales.

Against such a prolongation are two considerations. The first is, that the bank being left to form beyond the influence of the piers might spread over too wide an area, to the possible blocking up of the entry. The second is, that even should the bank form only in a continuation of the line of its present position, vessels entering the port with a northerly wind would have the bank under their lee, without the protection they now enjoy from the north pier, which prevents their being set on to the bank. This question will probably be set at rest by experiment, by prolonging the south pier. Should its co-extension with the north pier be found to offer more hindrances than advantages to the navigation, the north pier can be extended until it again projects beyond that of the south.

This experiment can be tried at a moderate cost, and, as it can but result in a general prolongation of the piers into deeper water, must lead to a decided improvement of the entry—with the additional advantage of showing which is the best relative extension to establish for the two piers.

LONDON STREET SWEEPING.

In a former letter some account was given of the vast subterranean works by which London is drained and purified, and it now remains to speak of the operations above ground, the cleansing of the immense area occupied by the modern Babylon. Some estimate of the extensive nature of these operations may be formed when we reflect that the streets of London, if placed in one line, would form an avenue of 7,000 miles in length. In the daily cleansing of the streets about 14,000 men find employment, which gives an average of two to the mile, but the number fluctuates according to the season. In the service of this army are 6,000 horses and 2,400 carts.

The City Commissioners of Sewers, upon whom devolves the task of keeping the streets clean, do all their own work, and make the most, commercially, of the garbage with which they have to deal. The "city" has its own engineer-in-chief, at a salary of £2,000 per annum, and he has his staff of assistants, superintendents and men for the carrying out of every department of street government. One corps of laborers is told off for the sweeping of the streets; another for their washing; a third for the collection of the refuse; a fourth for the carting away of the same, and a special body is employed in attending to the public street conveniences. The payroll of the street cleaners amounts to £28,000 annually for the "city" alone, which would give a staff of about 560 men. These are divided into scavengers, carters, street orderlies, dust sifters, mud puddlers, etc.

THE NIGHT BRIGADE.

The work of street government goes on day and night, but the actual sweeping does not commence until eight o'clock in the evening. From that hour until daybreak files of men occupy the street, which are then hourly becoming more silent and empty as the night wears on, the laborers themselves moving their immense brooms with automaton-like regularity, and with an air of melancholy which befits the time and is in keeping with the dreary gloom around them. One wonders what becomes of these night birds in the day time. In what "rookery" do they pass the hours of light and sunshine? Do they ever talk or hold up their heads?—for one of the results of their occupation is a confirmed stoop of the shoulders. Whole regiments of them, formed in line, may be seen during the night performing their tasks and looking like brigades of hunchbacks. Most of them are old men, or at least look old, for one and all have that strange, wizened, dried-up look which defies any guess at real age. Some of them have taken to the business from downright affection, and their histories would form a strange and entertaining chapter of human biography. The story of one of them at least is known. The hero of it is now an inhabitant of one of the workhouses. Twenty years ago he drove his carriage and pair, and carried on a business which brought him in £10,000 a year. He lived luxuriously, kept open house, and took an active part in the local government of his district. Misfortune came, and in a single week he found himself an absolute pauper, and finally a street cleaner, sweeping the very pavement from which his own carriage had many a time stirred the dust. Some of the night workers do duty during the day as

"SANDWICH MEN,"

a slang term for the miserable creatures who perambulate the streets, carrying boards slung over their shoulders, before and behind, forming a kind of wooden chesable, whereon are pasted advertisements. Poor, broken-down men, with abject mien and gait, these walking advertisements traverse the muddy streets under their degrading burden for the vast sum of one shilling a day. When night comes they take to their brooms, and in the early hours of the morning may be found sleeping on the wooden settles of the common lodging houses.

THE CARTERS.

Following the army of sweepers comes the carts, each attended by two strong looking men, clad in dingy smock frocks and immense "sou'wester" hats, and bearing large shovels with which they scoop up the mud, dirt and other refuse and pitch it into the carts. Up in the narrow streets of the densely populated neighborhood a midnight stroll will reveal huge pools and heaps of offensive matter collected before the entrances of courts and alleys which have been brought by the night soil men from the backs of the poorer dwellings and await the arrival of the carts. Every ounce of the refuse is conveyed to depots, that is to say, large open spaces where the liquid matter is thrown into reservoirs made of mud, and is eventually transferred to barges on the river.

DISPOSITION OF THE REFUSE.

The fluid refuse having been shipped is conveyed towards the mouth of the Thames, where it is discharged into the water. The solid matter is differently dealt with. In the depot yards women and girls are employed in sifting the ashes and rags which are used for bottoms of new streets and other purposes. The cinders are used for burning bricks at the limekilns and the residue as cement or manure. The women employed in this dirty work receive generally $1.25 a week, and the maximum received by the men is about $6, while the barge owners get sixty cents per cubic yard for conveying the liquid refuse down the river.

THE MUD BARGES.

The crews of these barges are an extraordinary class of beings. Mr. Silas Wegg, "to whom all print was open," knew them and their ways, but they are now hardly as lively a race as when the Golden Dustman dealt in their wares. They spend their life on board the barges, men and women together, and, as a necessary result, children often see daylight, or, more frequently, a London fog, for the first time in their filthy little holes called cabins. The language of this floating population is peculiar. It is a *patois* of the rough sailor's style of blasphemy with a mixture of the costermonger—Romany jargon. "They do swear most awful," these uncouth mariners, and have an unconquerable aversion to the white tie of the evangelizer and the uniform of the river police. All the efforts of benevolence, committees of lords and gentlemen and societies of ministers to christianize these unruly nomads have failed. A gentle lady, who has a decided talent for evangelization, has been known to visit the bargemen in their abominable haunts, but even she did not make the slightest impression. They enliven the monotony of the voyages down the stream by puddling the mud and examining the cargo with all the scrutinizing, covetous instinct of the Parisian *chiffonnier*, in search of such valuables as may have escaped the operators at the depot. Whenever they "make a haul," which is not an unfrequent occurrence, they signalize their good luck by a drunken orgy in the public house nearest to their moorings by the river side. It is said that many an assassin's secret has been hidden in

the hold of a Thames mud-barge. The police suppose that many of the dead bodies found in the river, especially those who bear upon them the marks of foul play, have been thrown overboard from the barges. The bargemen, they say, may receive a "parcel," with instructions to discharge it with the cargo or to drop it quietly to the bottom on their way down with the tide.

THE CROSSING SWEEPER.

At what precise date in the history of London this knight of the broom made his appearance is not on record, but to judge from what London was and what it still is, his services must have been indispensable at a very early period, and, indeed, were far more necessary in the London of the past than in that of our own days, as will be evident from a quotation from Knight's work on the metropolis.

THE LONDON STREETS IN 1720.

"The middle of a paved street," he says, "was generally occupied with the channel, and the sides of the carriage way was full of absolute holes, where the rickety coach was often stuck as in a quagmire. The only road to the houses of Parliament before 1750 was through King street and Union street, "which were in so miserable a state that fagots were thrown into the ruts on the days on which the king went to Parliament, to render the passage of the state coach more easy." The present St. Margaret's street was formed out of a thoroughfare known as Saint Margaret's lane, but which was so narrow that "pales were obliged to be placed, four feet high, between the foot path and the coach road, to preserve the passengers from injury and from being covered with the mud which was splashed on all sides in abundance." The pales preserved the passengers more effectually than the posts of other thoroughfares. These posts, in the principal avenues, constituted the only distinction between the footway and carriageway; for the space within the posts was as uneven as the space without. This inner space was sometimes so narrow that only one person could pass at a time, and hence those contests for the wall that filled the streets with vociferations of anger and the din of assaulting sticks and sometimes the clash of naked steel. Dr. Johnson describes how these quarrels were common when he first came to London, and how at length things were better ordered. But the change must in great part be imputed to the gradual improvement of the streets. In Gay's time there was no safety but within the posts:—

> Though expedition bids, yet never stray
> Where no ranged posts defend the rugged way;
> Here laden carts with thundering wagons meet,
> Wheels clash with wheels and bar the narrow street.

In wet and gusty weather the unhappy walker heard the crazy signs swinging over his head, as Gulliver describes the Red Lion of Brentford. The spouts of every house were streaming at his feet or drenching his laced hat and powdered wig with unpitying torrents. At every step some bulk or shop projection narrowed the narrow road and drove him against the coach wheels. The chair-men, if there was room to pass, occupied all the space between the wall and the posts. The "hooded maid" came sometimes gingerly along, with pattens and umbrella (then exclusively used by women), and of courtesy he must yield the wall. The small coal man, the sweep and the barber took the wall, in assertion of their clothes spoiling prerogative, and the bully thrust him or was himself thrust "to the muddy kennel's side." But at whatever period the crossing sweeper first took his place as one of the institutions of London it is certain that he has ever been an interesting subject of study to novelists and essayists and occupies a distinct space in English literature. His was always a prosperous trade, no doubt, in such a muddy city as London; although not many, like Charles Lever's hero, could have left their crossings to become diplomatists and dine with the Prince Regent. In the days of the Regency the crossing sweepers had a trade union of their own, with rules unwritten, but rigid. Not more than twenty years ago there existed in one of the back slums of Oxford street a tavern where the West End sweepers used to take their ease in their inn. Here was kept a record of vacant crossings and a list of such members of the fraternity as desired to retire from business and sell their interest. There is a story of one old fellow, with a wooden leg, who waited for years before he would retire. He owned a crossing in Pall Mall for which he wanted $1,000. He had established the crossing himself, in the days when clean swept paths across the streets were more wanted than they are now, and had swept it for twenty-five years. It was worth $5 a day to him on an average; the "nobs" knew him, he said. A certain noble lord gave him a half-crown every day for keeping the mud off of his patent leather boots, and a duchess, he averred used to smile on him so blandly whenever she crossed that the old man almost forgot to hold out his trembling hand for the coin, which on occasions was a five shilling piece. He sold his crossing at last, and for years after frequented the sweepers rendezvous, where he generously assisted his less fortunate brethren of the broom.

STREET ORDERLIES.

Any visitor who for the first time walks the streets of London will be surprised and amused by the legion of boys, distinguished by a brass plate on their caps, who rush about the carriage ways, sometimes on all fours, and recklessly precipitate themselves in front of rapidly advancing hansoms, omnibuses or drays, with an apparent determination to commit suicide. Where certain death seems inevitable, there will the "street orderly" be found. Where two vehicles are swiftly approaching each other in a narrow street and there is barely room for them to pass, then is the moment for him to rush forth between them. If the traffic be dull and the street half empty of vehicles, you may look for him in vain, but amid the clatter of a hundred hoofs, the rattle of many wheels, there may you see him plying his brush and shovel. For his business is to collect the horse droppings in the very heat of the traffic. The wonderful agility and coolness of these boys is acquired by a course of training under the superintendents of the streets. The lad who aspires to the dangerous vocation of a "street orderly" must not be less than twelve years of age, and he cannot continue at it after he is sixteen. There are 140 of these boys employed by the authorities at wages varying from $1.50 to 2.25 per week, according to age and length of service. For ten hours of each day do they rush about the streets and dodge for their lives. Having filled their shovels with the manure they empty it into iron bins erected at intervals along the sidewalks and it is then removed in carts and sold. The manure is worth at the lowest value $5 per ton, and he must be a lazy orderly indeed who, in a crowded thoroughfare, does not collect a ton in a week. The average, in fact, is about a ton and a quarter. The boys are for the most part children of the men already in the employ of the Commissioners and are destined as a rule to spend their lives in the noble avocation of street cleaning. It is an amusing fact, that the manure bins are so frequently mistaken at night time for pillar posts that the carters are instructed always to carefully examine their unpleasant contents, and not a morning passes without a considerable number of letters—business letters, love letters, letters containing money and valuables—being forwarded to the Post Office as a result of the examination.

STREET FISHERS.

The street fishers, inasmuch as they have a hand in the work of street cleaning, deserve a passing notice This industrious class of the motley population of the great city is composed chiefly of women. Now that the work of general cleansing is undertaken by the public bodies, the female street fisher is to be found in courts and alleys, in the back slums and the streets leading to the river. She is not young. She is not beautiful. She is either a sturdy, middle-aged Amazon, or a decrepit old hag. Clothed in a mass of shapeless rags, occasionally enveloped in a man's overcoat, a tattered bonnet on her unkempt head, her stockingless feet thrust in a pair of rough shoes, she may be seen, stick in hand, basket on back, setting forth in the early morning on her rounds. From the dust heaps she extracts rags, bones, broken bottles—anything that is of the slightest value. She follows the coal carts and picks up the droppings, and watches the great wagons laden with vegetables for the same purpose. Round the warehouses and factories she prowls, gathering up any stray fragments of raw material which may lay about the gateways. A few grains of Indian corn—a little oatmeal burst from the package—will furnish the poor creature with a meal for the day. At night time she betakes herself to some back yard or the underground kitchen of her lodging house, where she sorts her treasures into lots, disposes of them for a trifle to the dealer, who in turn takes them to the manufacturers. All the finds of the street fisher are not so marketable, for now and then under a dirt heap a dead baby is brought to light. A certain class of street fishers devotes itself to the collection of dead animals. It is computed that every year the London streets and alleys yield a harvest of 500,000 dead dogs and cats. Their skins and entrails are utilized for various articles, such as gloves, fur-caps and fiddlestrings, while the flesh—but the horrible thought of sausages urges us away from pursuing the subject further! When, at last, after years of this hard, unsavory life, the street fisher dies in the Workhouse, she is bundled into a shell and buried with little more ceremony than if she was one of the dogs or cats by which she made her living.

THE CONTRACT SYSTEM.

The contracts made by the vestries for the cleansing of the streets are generally for a term of years. Every department of the work is contracted for, including the sweeping, watering and carting, and in most cases the contractor receives the refuse to dispose of as he chooses. In this way the Buffinses of old and of to-day amass fortunes before they have mastered the alphabet. They do what the vestries, one would think, might do for themselves—carefully sort and select the refuse of the streets and turn it to good account. The smallest piece of waste paper found among the debris has for them its commercial value, and the rich manure which is manufactured out of street sweepings yields them a large profit. But even without these "perquisites" the prices at which they obtain their contracts would enable them to acquire moderate fortunes within a short time. The contractors have really a vested interest in and a monopoly of the work of the local bodies. Nominally, of course, the contracts are open to competition, but the tendering is probably a mere pretence. The contractors are of a lower class than even the vestrymen, and as their business is a particularly repulsive one, which cannot be properly conducted without close personal attention to all its details, they have but a small competition to overcome. They generally begin in a small way—often on money borrowed from some of the vestrymen (at heavy interest, no doubt), and as the less experienced or less intelligent men fail for want of means in performing the small contracts the more successful man buys them out. In this way one contractor has been known to acquire contracts for nearly the whole of one side of the river Thames, within the metropolitan area. An Irishman, and coming to London with nothing but his rich brogue and mother wit for capital, he now lives in a magnificent suburban villa surrounded by ornamental grounds, keeps carriages and horses, but yet visits daily his dirt depots and personally superintends all the details of his immense business. He will die a millionaire, and the name of Daniel Redman—for so is the Golden Dustman called— will be remembered as that of the largest and wealthiest employer of street labor on this side of the Atlantic. If a company with adequate capital were to undertake the whole cleansing of the vast Augean stable by contract the work would yield a good profit, and at little more than half the present cost, but the present practice is so much a part of the system that there is not much chance of any change.—*N. Y. Herald.*

Accident to a Caisson at the Willems Bridge, over the River Nieuwe Maas at Rotterdam. By D. A. WITTOP KONING.*

An accident of a serious nature occurred during the sinking of the caisson for that pier of the railway bridge which is close to the quay wall of the town. Excavations had to be made in the caisson under compressed air, supplied by two force-pumps on a staging erected on piles round the caisson. The latter was of oblong shape, 84 feet 7 inches long by 24 feet 6 inches wide, with semicircular ends. It consisted of two chambers; the lower one was 11 feet 9 inches high, with sides of wrought iron lined with brickwork, with a roof of concrete and brickwork carried by iron beams; the upper chamber, fixed upon the roof of the former, was constructed of wrought-iron segments, bolted together, and stiffened inside by angle irons and a strong lining of brickwork. Four shafts connected the chambers; two for materials, and two for

*Abstracts of Papers in Foreign Transactions and Periodicals. The Institution of Civil Engineers, London.

the workmen. The caisson was built ashore upon a slip, and was floated out to the site between two pontoons, air being pumped in to keep it floating. Having arrived over its position, the staging was closed around it, and bricklayers were set to work to carry up the lining; the pier thus gaining weight, sank gradually.

Unfortunately, however, the cutting edge at the north side struck the piles of the surrounding staging and the caisson, being held up at one corner, went off the level. Air was pumped in again, but, though the rising tide lifted it off the piles, it struck some boulders which had been thrown around the caisson to prevent scour. The south side, now clear of the piles, continued sinking, and, in spite of all efforts, could not be stopped until the pier was leaning at an angle of 45°, having considerably damaged the surrounding staging in its course.

The contractor saw no other way of bringing the caisson back into its place, except by tackles fastened to anchorage on shore, which would have been no easy task, owing to its great weight and unfavorable position. The tackles would have required chains to be passed round the caisson, and it was feared that the latter would not be strong enough to withstand the pressure, and would either have parted from the lower chamber or collapsed. It would have necessitated on shore strong and expensive anchorage in the soft strata behind the quay wall, and it was calculated that a force of 1,000 tons, by means of fifty cables, each bearing a strain of 20 tons, would have to be applied.

Among the numerous proposals, that of the author was selected. He advised the building of a cofferdam inside the caisson, which, when pumped dry, would, as he demonstrated, yield a floating power three times greater than required. Amongst other advantages, his scheme obviated all danger of bringing the pier up suddenly. The lifting force had its greatest leverage at the moment when the greatest force was required, namely, in the beginning, diminishing gradually until the pier was in a vertical position, and its centre of gravity in the same vertical line with the centre of flotation.

The dam was commenced on June 15th, 1875, and consisted of double-grooved sheet piling, 39 feet long, 10 inches thick. At first each pile was set separately, by a diver, in a sext cut for it in the brickwork. As the work progressed, it was found advantageous to set them in sets of four at a time. They were pressed together by a windlass, and the joints were caulked with oakum. In spite of this precaution, much trouble was encountered through leakage. After spreading a tarpaulin over the outside of the dam, two centrifugal pumps, driven by two portable engines, were started on September 24th, the diameter of one being 7 inches, that of the other 4¾ inches. When a difference of 3.15 inches between water-levels was observed, the pumps had to be stopped and the leaks repaired. It appeared that the dam had come away from the ironwork at the east end, and a considerable leak had to be stopped with old sacks and clay. Pumping was recommenced on October 7th with five pumps and five engines. A difference of 4 feet 4 inches was attained, whereby the first definite rising of 2.36 inches was noted. By this mode of working, this angle was reduced from 45° to 22° 25′ on October 28th, when the greatest difference between water-levels, 16¼ feet was noted. It was now decided to apply mechanical power by chains and crab-winches. On November 1st, when the pier stood at an an angle of 16° 45′, the west cable parted, the links being 0.98 inch thick. It was made good, and work resumed with a strong flood tide, when the last cable, with links 1.34 inch thick, gave way. Accordingly it was determined to have recourse to compressed air in the bell, which was forced in on November 3rd. This was followed by an immediate rise of the pier, and improvement of the angle. The inclemency of the season now put a stop to further work. In the meanwhile everything was prepared to start with a fourth method, consisting in the application of screwjacks applied to the south side of the caisson, arrangements being made to prevent the north side from rising, so as to cause the caisson to move bodily to the southward. This effect was still further increased by casting more rubble stone on the north side. During this work, 2,000 tons of stone were tipped on the north, but none on the south. Bad weather continuing, the travellers were erected; the staging was finished and protected against ice-drift, and the iron skin of the caisson was carried up to withstand the extraordinary height of the tides. On January 26th, 1876, it was first possible to start screwing up, the clay having been removed from inside the southside to lessen the resistance; and on February 9th the latter rose 19.68 inches, reducing the angle to 3° 50′. The lifting was then stopped; the screws were wedged up, and the air let off. During this period, the sinking of the pier to its ultimate depth, and the building up of the brickwork slowly advanced. By distributing the brickwork, and by careful excavation, the pier was brought quite upright. The work was greatly impeded at this time by high tides. On May 24th—one year and three weeks after the commencement of operations—the pier reached its ultimate depth.

In its fall it had slid from its proper position to the northward, so that at the east end it was 6.9 feet, and at the west end 8.36 feet from its intended place. By tipping a bank of rubble on the north side, the displacement was reduced at the end of the second period to 5½ feet of the east end, and 7½ feet at the west end. Afterwards this was further reduced to 10.68 inches and 4 feet 5 inches at the respective ends, so that no alteration of the superstructure was necessary.

CORRESPONDENCE.

RICHMOND, VA., *June 4th, 1877.*

Editor ENGINEERING NEWS:

SIR.—Can you put this problem before your readers in such a form as to elicit a solution, or can you refer me to any text book containing the information? I know of none.

In a railway culvert the cross section of which is a parallellogram surmounted by a semicircle, what proportion should exist between the sides of the parallellogram?

Very respectfully yours,

SUBSCRIBER.

PORT EADS, LA., *May 29, 1877.*

Editor ENGINEERING NEWS:

SIR.—The scour at the upper portion of the jetties is progressing very favorably and the deep water contours are steadily advancing seawards. The greatest channel depth at present is at a point 4,900 feet below the Eastern Landsend, or nearly half way down toward the seaends of the jetties. The depth, which is 74½ feet, is at the same spot where the coast survey map of 1875 shows 13 feet. The volume of sand removed from within the jetties between the 2d of March and 26th of May of the present year, amounts to 467,000 cubic yds. Taking into consideration that scour can only be effected by expending velocity on friction, it is evident, that in order to accomplish the removal of such a waste mass of material, the bearing capacity of the volume passing through the jetties had to be taxed very considerably, adding, in this instance, for the time being, in the average not less than 13 per cent. to the already enormous amount of sediment which the Pass carries in suspension. Considering, furthermore, the fact that this addition is being applied at a moment when the volume is ready to enter the Gulf, you will find it doubly surprising, that no trace of a deposit can be found beyond the crest of the bar. But examinations of the Gulf bottom directly in front of the jetties, made this mouth give evidence that the depth over the entire area investigated (51.7 acres), is now 4.99 feet greater in the average, than it was in the same locality in May, 1875. A more convincing proof for the success of the improvement can hardly be found. Very truly yours,

MAX E. SCHMIDT.

OGDENSBURG, N. Y., *May 30, 1877.*

Editor ENGINEERING NEWS:

SIR.—Your paper last year contained some extracts from my report on the Construction of the Kansas City Water Works.

After their completion so far as to enable them to meet the requirements of the contract for their construction and operation, the city refused to accept their services and the controversy finally passed into litigation. The city procured the services of two engineers from St. Louis, whose report, carefully kept from the Water Company for use in the then pending trial, has first been made public through the columns of your paper, (April 21, 1877).

These gentlemen are well known to be opposed to the Holly system of water supply. One of them had made an estimate for reservoir works at Kansas City previous to the inception of the present works, his estimate footing up something over a million, and a perfectly fair report could hardly be expected from them, especially as made for the express purpose of doing the works all the injury possible. I was not, however, prepared for their sweeping condemnation, and as the controversy between the city and company has been amicably adjusted by a compromise of the original contract, satisfactory to both parties, the only effect the paper could have at the date of its publication is on my standing as an engineer.

I therefore wish the privilege of a reply, this being the first leisure I have had since its publication.

Their first attack is on the quality of the water supply; this, by the terms of the contract, is a question for chemists, not for engineers; but they see fit to infer fraud on the part of the company in sending samples of water for analysis different from those obtained at the source of supply.

I was present when these samples were taken by the water commissioners from the sources named in the pamphlet and know them to be as represented.

Their next is on the quality of material and workmanship: first item, receiving cribs at the Kansas river. These were built of the best quality of southern pine; that portion above low water will need occasional repairs when the timber fails from age; that they are efficient is undeniable, and the cost of maintenance will be less than fifty dollars per year.

It is not to be expected that a private corporation will do as expensive a class of work as that which has made the five million water-work's debt of St. Louis, but as they are to own and operate these works for twenty years they would not naturally wish to do merely temporary work.

The receiving well next takes attention; the lower part of this, of boiler iron painted thoroughly before sinking, is claimed to be temporary, and liable to rust out. I believe this will last longer than the present capacity will be sufficient, but it is fully accessible and can be lined with brick at any time if desired, at a cost of about two hundred dollars.

The reservoirs come next; to describe the construction of these in detail would occupy too much space. They were built upon plans based on the authority of twenty-five years successful use, and were submitted to and had the approval of practical and able engineers. The tops of the banks were originally ten feet wide, inner and outer slopes 1½ to 1; the tops have since been rounded off; they were intended to have been grassed outside, but this has not been done as yet. The brick facing in the lower reservoir is set in cement, and the limestone facing of the inner slope of the upper reservoir is an edge paving, filled in next the earth with small stone—the character of the earth is such that it will hold water permanently when simply filled in with ordinary embankment. The most of the upper reservoir is excavation; where it approaches the crest of the hill it has an outer retaining wall, the base of which is equal in breadth to its height; at this, the narrowest part, the embankment including the retaining wall is 70 feet thick at the base and 20 feet at the flow line. At present they are of ample capacity for all requirements and land is provided for their extension when necessary; the concrete of the lower reservoir and the tops of both embankments (the surface of which is in the report called "plastering"), was injured by frost, and cement was provided for its renewal last year; the work was, however, delayed till the present season by fear of frost.

The placing of all the machinery in one building was not my work, and I think the company believe as I did then that two pumping stations would have been better. The present arrangement, however, is objectionable not on account of lack of efficiency, but from the complication of machinery necessary to obtain the required results.

Ability to perform tests of throwing streams for fire service; here they propose to use an outside line of pipe which at the request of the water commissioners was changed from its direct connection with the system of mains as originally planned, and carried around a circuit of about a mile, to serve an otherwise isolated locality, on which it is not probable that more than two or three streams would ever be required at one time. Small and long as this line is, however, 12 one-inch streams have been thrown from it at one time to heights of from 100 to 140 feet. A trial of streams in lower town, as indicated, would very soon convince any one desiring it that there *was* a communication with the machinery; this is usually kept closed to relieve lower town of excessive pressure; the reservoir pressure being sufficient for all requirements.

Estimates of cost: On this subject I am not at liberty to speak definitely, the company not having made their expenditures public. It is evident, however, that their estimates are based on a like view with the rest of their report. For instance, the building and well which cost some $43,000 by day labor is estimated at $20,800, and the machinery weighing some 200 tons, and of a class approaching locomotive work in cost, is estimated at $50,000. G. W. PEARSONS.

CHARLESTOWN, MASS., *May 28, 1877*

Editor ENGINEERING NEWS:

SIR—In reading over the excellent discussion of the theory of the braced arch given in Prof. Du Bois' "Graphical Statics" (John Wiley & Son's Edition), I have found the following corrections necessary, which it seems desirable to bring before the readers of the work at once. At the request of Prof. Du Bois I therefore transmit them to you, hoping you will give them a place in your journal for the benefit of those who may have occasion to use the article referred to.

I will first state that the errors here given affect mainly but a single chapter in a supplement, and not the general theory, which is correct, or the main portion of the *text* of the braced arch, in which, on the contrary, with a single slight exception given below, no essential errors have been found in a careful and thorough perusal.

I would also state that the development of the theory of the braced arch given in this book is one of the best and most satisfactory to be found in the English language; and from what I have read of the work, I regard it as one of the best books relating to the engineering profession, and value it highly.

The corrections are the following:

On page 268 the last line should be $M = Hy + M$.
x

On page 286, in the last formula, for the term "$2\,(1+k)\,\alpha\cos.^2\alpha$," substitute $2\,(1+\frac{k}{2})+\cos.^2\alpha$.

On page 296, last line, for "large" read "small."

On page 305, equation (72) should be

$$H = \frac{P\,(a^2 - 2az \pm z^2)}{4h},$$

in which the sign $\pm$ is to be used according as z is essentially positive or negative.

On pages 307 and 308 erase from "(*c*) Moment at unloaded end" to "34. Circular arch," and substitute the following: For the moment at the crown we have from (37), Art. 14, for a single load

$$M_0 = -\frac{1}{32}\frac{P\,(3a^4 \mp 16a^3 z + 18a^2 z^2 - 5z^4)}{a^3},$$

in which, again, the sign $\mp$ is to be used according as P is to the left or right of the crown, or z positive or negative.

Taking the first expression and substituting for P, $-pdz$ and integrating between the limits a and z, we have for the moment at the crown when the load, coming on at the left, does not extend beyond the crown:

$$M_0 = \frac{p}{32a^3}[z\,(3a+2)\,(a-z)^3]$$

This expression is zero for $z = 0$; and hence, when the load extends from the left abutment beyond the crown, we shall obtain the moment at the crown by substituting for P, $-pdz$ in the second of the expressions given above for M_0 in the case of a single load, viz:

$$M_0 = -\frac{1}{32}\frac{P}{a^3}(3a^4 + 16a^3 z + a^2 z^2 - 5z^4),$$

and integrating between the limits 0 and z; — which gives

$$M_0 = \frac{p}{32a^3}\,z\,(3a - z)\,(a+z)^3.$$

Hence, we have the general formula

$$M_0 = \frac{p}{32a^3}\,z\,(3a \pm z)\,(a \pm z)^3,$$

in which the upper row of signs is to be used when z is positive, the lower row when z is negative,—the sign of z being implied in it.

M_0 has its maximum positive and negative values for $z = \pm a\,(-1+\sqrt{\frac{8}{9}}) = \pm 0.264911\ a$, or nearly $\frac{1}{4}\ a$.

The moment at the unloaded end is given by the formula

$$M_2 = \frac{-p\,(a^2 - z^2)^2\,(a-z)}{16a^2},$$

in which z may be be either positive or negative.

This moment is always negative, and has its greatest value for $z = -\frac{1}{3}\ a$.

The values of V_0, H, M_0 and M_2 are given in the following table:

z	V_0	H	M_0	M_2
1.0	0	0	0.000	0
0.9	0.00024	0.000579	+0.0001097	−0.0002256
0.8	0.0019	0.00428	+0.000760	−0.00162
0.7	0.00624	0.013306	+0.002185	−0.00487688
0.6	0.0144	0.02896	+0.004320	−0.01024
0.5	0.02734	0.051758	+0.006836	−0.0175781
0.4	0.0459	0.08154	+0.009180	−0.026460
0.3	0.07074	0.11758	+0.010612	−0.0362294
0.2	0.1024	0.15872	+0.010240	−0.04608
0.1	0.14124	0.20344	+0.007062	−0.0551306
0.0	0.1875	0.25000	0.00000	−0.0625
−0.1	0.24124	0.29656	−0.00 062	−0.0673819
−0.2	0.3024	0.34128	−0.010240	−0.06912
−0.3	0.37074	0.38242	−0.010612	−0.0672831
−0.4	0.4459	0.41846	−0.009180	−0.06174
−0.5	0.52734	0.44824	−0.006836	−0.0527344
−0.6	0.6144	0.47104	−0.004320	−0.04096
−0.7	0.70624	0.48669	−0.002185	−0.0276356
−0.8	0.8019	0.49572	−0.000760	−0.014580
−0.9	0.90024	0.49942	−0.0001097	−0.0042869
−1.0	1.0000	0.5000	0	− 0
a	*pa*	$\frac{pa^2}{h}$	pa^2	pa^2

On page 310, line 2, read

$$H = \frac{pr}{24\left[(1+k)\frac{\pi^2}{4} - 2\right]}\Big\{[\pi - 6\beta - 18\sin\beta\cos\beta - 12\beta\sin^2\beta + 6\pi\sin\beta + 2\pi\sin^3\beta + k(-5\pi - 12\beta\sin^2\beta + 6\beta - 6\sin\beta\cos\beta + 6\pi\sin\beta + 2\pi\sin^3\beta)]$$

For line 5, page 310, read

$$H = \frac{pr\,(\pi - 6\pi k}{12\left[(1+k)\frac{\pi^2}{4} - 2\right]}$$

Line 6, page 310, for "unloaded end" read "crown."

Line 8, same page for M read M_0.

Line 12 " " M read M_0.

Lines 15 and 16, same page, should read thus:

For a uniform load over the whole span the moment at the crown would be twice as great as for a load on half the span, for which β would be equal to 0, and hence for a full load

$$M_0 = \tfrac{1}{2}\,H\,r\left(2 - \cos\alpha - \frac{\alpha}{\sin\alpha}\right) - \frac{pa^2}{6} \quad . \quad . \quad . \quad (83)$$

As before stated, this communication is made at the suggestion of Prof. Du Bois for the benefit of those possessing the book.

Yours very truly,

C. W. KETTELL.

BOOK NOTICE.

Strength and Determination of the Dimensions of Structures of Iron and Steel, etc. By Dr. Ph. J. J. Weyrauch. Translated by Prof. A. J. DuBois. New York: Wiley & Sons.

Strength and Calculations of Dimensions of Iron and Steel Constructions, with Reference to the latest Experiments. Translated from the German of J. J. Weyrauch, Ph. D., Polytechnic School of Stuttgart. With four folding plates. New York: D. Van Nostrand.

We have devoted considerable time to a careful reading of the above book, and have laid it down with mingled feelings of approval and of disappointment. So far as the publishers are concerned, their work has been done in an excellent manner, and the volume is presented in a very attractive form. As will be seen by reference to the advertising columns of Engineering News, two editions are offered to the public at the same time, and the consequence is that the price has been placed at a very low figure. On a comparison of the two it would be found that the copies put forth by Messrs. Wiley & Sons, while not entirely free from typographical errors, have evidently been more carefully revised than those issued by the other house, and some of the errors of the original have been copied in Van Nostrand's edition. Most of all such mistakes are, however, at once discovered on a careful reading of the text. Wiley & Sons have also added, by way of appendix, and as naturally harmonizing with the subject under discussion, several papers by Prof. Thurston, of the Stevens Institute of Technology, which, while they are to be found in various society publications, have never been before collected in book form. As the edition of the Messrs. Wiley & Sons has been specially authorized by Dr. Weyrauch, and he receives a copyright on the same, we should, even if the editions were of equal merit, prefer to contribute towards rewarding the original author for his labor.

The book aims to set forth a new method of calculating the dimensions of the several portions of a structure in iron and steel, for resisting the stresses previously determined by the common statical methods, and naturally considerable space is devoted to the ultimate strength, elastic limits, influence of chemical composition, mechanical treatment, temperature, etc. The attention of the reader is strongly called to the fact that repeated stresses, of less intensity than the breaking stress, may cause a piece to fail, and that the safe stress is one which, for bridges, where unlimited duration is desired, may be repeated an infinite number of times without producing fracture. It is then shown that pieces under a certain permanent stress and an additional, more or less frequent, stress of the same kind from traveling load have a different power of resistance, and that parts which are subject to alternating stresses of tension and compression are most unfavorably situated and have the smallest resisting power. This fact is quite commonly recognized already by good designers in this country, as is shown by the avoidance of such members in the web of a truss, by the introduction of two tension diagonals in such panels of the ordinary quadrangular bridge truss as are subject to a reversal of the shear, and by the addition of tension members in connection with the struts near the middle of the span of a Warren Girder as sometimes built.

As a means of further drawing attention of engineers to these points and of enforcing greater care in proportioning sections for varying forces, this volume will do much good, and we can commend it to the profession for this reason. But we cannot resist the feeling that the experiments are lacking in number, exactness and coincidence of results, and that therefore the formulæ are generalized from insufficient data.

The chapters devoted to the strength of riveted joints and the arrangement of the rivets have served to confirm the opinion that we know very little of the real working strength of many of the complicated connections found necessary in riveted bridges. The transmission of the stresses from the web members to the chord plates in a bridge truss, without straining the angle iron or the vertical plate connection beyond the desired amount, and with an assured economy of material, still seems a difficult problem. Most American engineers would have preferred a chapter on the proportion of eye-bars and pin connections.

One important point in which the formulæ set forth by the writer fail is in not taking account of the length of a compression member. Thus, where a piece is subjected to alternate compression and tension the formula is, the allowable safe stress per square inch for wrought-iron in pounds

$$b = 10{,}000\,(1 - \tfrac{1}{2}\,\frac{max.\ B'}{max.\ B})$$

where B and B′ represent respectfully the greater and the less of the two opposite maxima stresses. Then in applying it to a truss where a diagonal has at one time 9550 units of tension and, at another, 4600 units of compression, he makes

$$b = 10{,}000\,(1 - \tfrac{1}{2}\,\frac{4600}{9550}) = 7586 \text{ lbs.}$$

As 9450 kilograms = 21054 lbs., the cross-section will therefore be 2.8 sq. inches. As no dimensions are given for the truss referred to, there is no means of judging whether the diagonal is five feet long or twenty feet, and he nowhere intimates that the length is a disturbing factor in the calculation for the resistance to compression. We were also surprised that in such a work no allusion was made to the theory that shearing stress is not uniformly distributed over the cross-section of bolts and pins and that hence an increase of section is called for.

The author concludes in the following words:

"If, now, anyone declines to make use of the advantages which the new method presents as regards the saving of material, that is his affair. The construction will not be any the safer thereby; but he who expends the material is only answerable to him who pays for it. It cannot, however, without danger, be allowed to subject pieces which are alternately extended and compressed, and of which an unlimited life is expected, to a stress of 10,000 lbs. per sq. inch. He who will go no further may, at least, calculate the cross-sections for pieces in alternate tension and compression, as in the practice in America, from the formula

$$\text{Cross-section} = \frac{max.\ B + max.\ B'}{10{,}000}.$$

The stresses thus obtained compare not unfavorably with those obtained from the formula based upon Mr. Wohler's law."

We should be glad to hear from some of our readers how much and where the formula credited above to America is used in this country.

NOTES.

The Youngstown, O., rolling mills burned a few days since. Loss $100,000.

An amount of stock sufficient to start the cheap cab enterprise in New York City, has been subscribed, and their appearance is promised in October.

The Akron Iron Company at a special meeting, recently, resolved to increase the capital stock by $75,000, on account of the changes and improvements now being made, and the stockholders will furnish the entire amount in cash. An excursion to the new coal and iron lands of the company in the Hocking Valley is talked of.

The Governor of New York, at Albany has signed the following bills:—

Providing for the Stevenson traction system of towage on the Erie Canal. Providing for a deficiency in the appropriation for ordering repairs of the canals for the fiscal year ending September 30, 1877. Authorizing the Canal Board to close the feeders of the Erie Canal in Rochester. Providing for the introduction of an improved system of steam towage upon the Canals of the State.

A plant has been newly found out in Lukhipur, Hindostan, the leaves of which turn very much to the shape of a grasshopper in proportion as they grow old, till all the parts of the insect so formed become beautifully

developed; and each leaf forming, a separate insect issues out in very beautiful appearance. This plant is known to grow by itself, and no second plant has yet been seen to grow from it.

Millerstown, Pa., was threatened with utter destruction as the result of a singular accident which took place on the evening of June 2nd. According to our despatches, an oil tank was struck by lightning, and in an instant huge flames burst forth and the country was illuminated for miles around. Several other tanks almost immediately took fire, and the scene is described as terrific. A severe storm added to the horrors of the situation. Thousands of barrels of oil and other property were destroyed.

The Urbana, O., Council has decided that the only effectual means by which to obtain an ample supply of water is to construct wells of sufficient capacity, outside the drainage of the city, and erect a pumping machine. H. B. Clinch & Co. submitted a proposition to erect the necessary pumping apparatus of the capacity to furnish one million gallons of water daily, the city to pay the contractor an annual rent of $100 per hydrant, to the number of sixty. If the proposition is accepted the contractor is to begin work within ten days, and have the works in operation on or before November 1.

BAILROAD NOTES.

ERRATA.—In the note in our last issue, referring to the addition being built by the side of the P. C. & St. L. R. R., in Chicago, from Ogden avenue to the Stock Yards Junction, we were in error in stating that the C. B. & Q. R. R. Co. had completed the arrangements for that work; the Union Stock Yards and Transit Co. alone are concerned in the undertaking.

All railway travelers will be pleased to learn that a smoke, spark and cinder-consuming and self-feeding locomotive has been tested on the New York & New England R. R.

The Bedford R. R., 3-feet gauge, from Bedford to Billerica, Mass., eight miles, is being rapidly pushed to completion. Work was begun last fall, and suspended during the winter.

The track on the Rochester & State Line is now laid to Warsaw, N. Y., six miles beyond the last point noted and forty-one miles from Rochester, N. Y. A large quantity of ties are being distributed along the road south of Warsaw.

The Spartanburg & Asheville track is now laid to the South Pacolet River, 19 miles from Spartanburg, S. C., leaving 25 miles yet to reach Hendersonville. Work is progressing steadily and the company hopes to reach Cold Spring Gap in Polk County, N. C., by July 4.

The Albert, New Brunswick road is now completed from Salisbury, N. B., southeast to Hillsboro, 24 miles, and to some coalmines a short distance beyond that town. An excursion train passed over the road recently, and regular trains will run to Hillsboro very soon.

The grading of the Utah Western road is now completed to the tunnel near Stockton, Utah, thirteen miles westward from the terminus at Lake Point, and thirty-three miles from Salt Lake City. The ties are being distributed along the line and the rails have been purchased.

The contract for building the Stratford & Lake Huron road from Stratford, Ont., to Listowell has been let to W. G. Hay, of Listowell, the work to be completed by November. The town of Palmerston has voted a bonus of $21,000 to secure the construction of the road at that point.

Work is in progress on a section of the Putnam & Dutchess road from Newburg, Dutchess & Connecticut road at Clove Branch Junction, N. Y., north to the Clove Spring Iron Works, about three miles. The road was formerly included in the New York, Boston & Montreal combination.

The Narrow Gauge track is laid into Waverly, Ohio, and the work of ballasting the road is progressing. The Company last week received twelve flat and six box cars, and in a few days will have passenger coaches. We understand regular trains will be put on the road about the 15th of June.

It is proposed to build a railroad from San Antonio, Tex., to the Rio Grande at the most convenient point, for the purpose of opening the country west of San Antonio. In view of the importance of such a line in a military point of view, especially in the present disturbed state of the Mexican border, an effort is to be made to secure aid from the Federal Goverment.

The Midland R. R., 3-feet gauge, from Boston to North Reading, Mass, 18 miles, is located and construction commenced. Walter E. Bates, Chief Engineer. It runs nearly parallel with the Boston & Maine R. R. for a large part of the way but crosses it over head in Stoneham. Its location was a matter of much difficulty, and some heavy work in rock cutting will be be required with heavy grades and sharp curves.

A company by the name of New York, Brooklyn & Sea Beach has begun work on a line from East York (just outside of Brooklyn) to Rockaway Beach. Contracts have been let, and it is said that the road is to be completed in July. There are already two railroad routes from New York to Rockaway Beach, besides one partly by railroad and partly by steamboat, and a number of steamboats also run there during the summer.

The Boston, Revere Beach & Lynn R. R., 3-feet gauge, continues to be a success. It is heavily patronized in summer by visitors to Chelsea Beach, and cuts deeply into the traffic of the Eastern R. R. with which it runs parallel. It is proposed to extend it from Lynn to Newburyport, but great difficulty is experienced in finding a location through the city of Lynn. A branch is proposed to Nahant. Notwithstanding its unfinished condition and wretched location and alignment, no accident has yet happened, which may be properly attributed to its good track. Engine and car houses have been built at Winthrop Junction and also a machine shop.

The financial arrangements in the interest of the Montreal, Portland & Boston R. R. and its connections with the Southern Road, which E. H. Goff has been negotiating, have terminated successfully. Hon. Lucius Robinson, of New York, purchased from Mr. Angus his interest in the railway, thereby becoming part owner with Mr. Goff. Mr. Robinson has been appointed general manager, in place of N. A. Smith, resigned. The contractors expect to have the road completed to West Farnham by August 1. It there intersects with the Southeastern & Passumpsic Road, thus completing the Montreal & Boston air line. The company will eventually complete the road through to the Providence line to connect with Portland and Ogdensburg.

Russian railroads date back to 1838. The first line opened was from Zarskoe-Selo and Pawlosk. The road from Warsaw to the Austrian frontier was built immediately afterward, and then the line from St. Petersburg to Moscow. In the beginning of the present reign enormous subsidies were offered by the Government, which resulted in fifty lines being organized. Twenty of these were guaranteed to the full amount of their capital, twenty were partially guaranteed, and ten were built without Government aid. The total length of the roads is 20,000 miles, and the capital of the companies $1,500,000,000. The Government owns fully 50 per cent. of the entire railroad property.

A progress report of the Canada Pacific R. R. has just been laid before the Dominion Parliament. This line, let it be taken where it may, will have a bearing on our own commerce, and ere it is finished may be of considerable interest to us. Its route is practically determined from the head of Lake Superior to the first westward slope of the Rocky Mountains. From Thunder Bay in Lake Superior it runs through the heavy-timbered country on the north side until it strikes the head of the Lake of the Woods at Rat Portage—a lake, the south portion of which is in Minnesota—and 114 miles farther west strikes the Red River of the North, about a hundred miles on an air line from the international line which separates Minnesota and Dakota from the Canadian province of Manitoba. Thence it strikes northwest through the Saskatchewan country in the Canadian Northwest territories, and crosses the Rocky Mountains by the "Tete Jaune" or "Yellow Head" Pass, 1,053 miles from the Red River. Twenty-four miles over the rocks on the confines of Lake Superior have been built, and 226 miles altogether are now under construction. A telegraph wire has been laid as far as Edmonton, on the Saskatchewan, a Hudson Bay Company station, 807 miles west of the Red River, and several hundred miles north of Benton in Montana. This line, now in connection with our Western Union, will shortly be extended eastward to Thunder Bay and westward to the Rocky Mountain Pass, a distance of 1,475 miles. That portion, however, about which uncertainty remains is the one perhaps the most interesting to us. There are enormous difficulties to be overcome in carrying this Canada Pacific railway through the Cascade range, and the question of its Pacific seaport is still a matter of deep consideration with the Canadian engineers and the Canadian Government, and a subject of bitter contention amongst the people of Canada's Pacific province, British Columbia. There is a magnificent harbor at Esquimalt, but this is on Vancouver Island, and the difficulty of crossing from the mainland is great and expensive to overcome. The choice, then, falls between a terminus amongst the fogs and ice in the neighborhood of Alaska—a terminus which would seriously damage the commercial value of the railway—and a harbor in close proximity to the international boundary line. Strategical reasons forbid, of course, the placing a line of railway on the frontier, but the probability of the Canada Pacific ever being required, or of rendering effectual service if required, as a military road, is not, we should imagine, sufficiently strong to outweigh the more immediate considerations of cost, natural advantages and the requirements of commerce. At one time it was almost definitely determined that the road should eventually cross to Vancouver Island and to the port of Esquimalt, but there is now a strong tendency to further examine the line down the valley of the Fraser River to the ocean at Bunard's Inlet.—*N. Y. World*

FLORIDA NOTES.

The Railroad from Jesup, Georgia, through Jacksonville to St. Augustine, is partly completed, but work was stopped owing to failure of contractor. This is but the beginning of a road that will traverse the whole eastern coast of Florida to Key West, and there connect with a short line of steamers to Havana. The Great Southern R. R. Co. hold the charter and propose to re-commence work shortly. This road will open the garden of the State and the great orange-growing region of Indian River to settlers, and it is believed that it will become a popular route to Cuba for invalids and others, avoiding the boisterous passage by Cape Hatteras. It will also be the best line for the transportation of pine-apples, bananas, and other tropical fruits to the northern markets, which now are obliged to depend on vessels, and it is proposed to construct tank cars for the conveying of molasses in bulk The passage from Key West to Havana will occupy but about twelve hours, and freight to New York from Havana will go through in six days. The alignment will be almost perfectly straight and no cuttings of over six feet will be encountered, and no rock work on the entire line. The best of timber for bridges and ties exists in great plenty along the whole line, and no bridges over 150 feet in length will be necessary, except at the crossing of the St. John's river at Jacksonville. It is perfectly safe to say that no railroad in the United States of its length can be constructed cheaper and none that will pay a better dividend to its stock holders.

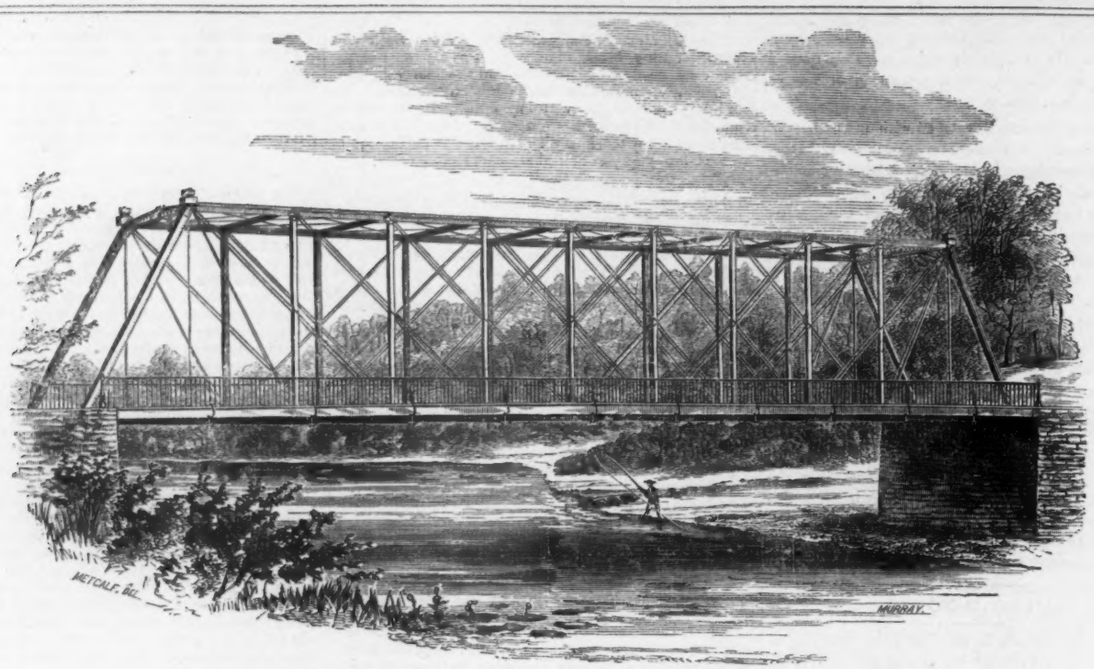
A canal is also proposed from the vicinity of St. Augustine, on the Mantonzas river, to connect with the Halifax river, with a branch to the St. John's river at Lake George. This canal, including the branch, will be 44 miles long, without locks, and will open a direct inland water communication of about 450 miles. The old canal, 26 miles in length, that was commenced before the war, from the St. John's river to the Indian river, north of Sand Point, has been abandoned and in its stead a canal only seven miles long is proposed from Lake Washington to Indian river at Eau Gallæ. This short canal will open a water communication of nearly 1,000 miles, and will enable steamers from Jacksonville to pass into Indian river, bringing the whole of that great orange and other tropical fruit country within seven days of New York. The Indian river country is the garden of the State, where all kinds of tropical fruits can be and are produced in abundance, but it is shut out from the world at present by want of steam communication. The imperative need of the Indian river country is free communication, and they mean to have it without delay. The State Agricultural College is also built at Eau Gallæ, at a cost of $100,000, and it is estimated that in four years over 500,000 oranges will require shipment from this river, not to mention bananas and other tropical fruits.

Another scheme for the relief of this section, is to enlarge the existing canal, 2,000 feet long, at the Haul-over, between Indian river and the Hillsborough river, and dredge about one-half mile in the Hillsborough river. This will give direct communication with the Atlantic at New Smyrna, and open nearly 230 miles of inland water communication. Steamers are now running on both the Hillsborough and Indian rivers, making a portage or transhipment at the Haul-over, and a company has been recently formed to run a line of steamers from Jacksonville to New Smyrna. It is further proposed to connect the waters of Indian river and Biscayne Bay by a canal to pass through Lake Worth, which canal would be 35 miles long, without locks, and would give direct communication with Key West, and form an uninterrupted inland water communication from Indian river to Cedar Keys on the Gulf coast, clear around the peninsula of Florida, a distance of over 600 miles.

Thus it appears that a series of canals aggregating only about 60 miles, easily constructed, and without locks, will give uninterrupted inland water communication from St. Augustine, on the east coast to Cedar Keys on the west coast, entirely around the State, a distance of over 700 miles. The Florida Inland Navigation Co. have been investigating the matter and have already made preliminary surveys. J. FRANCIS LEBARON.

The bids for the improvement of the harbor of Ontonagon, Mich., were opened by Major Henry M. Robert, Corps of Engineers, on Saturday, May 26, with the following results:—Thurlby & Watson, $9,726.00; Simon Emery, $9,280.00; Rosser & Winston, $9,130.50; Harvey & Hubbard, $8,954.25; Edmond Ingalls, $8,880,50; Thos. Keeler, $8,408.00; John E. Thomes, $8,394.90; McDougall & McLennan, $8,176.00; Chas. Fisher, $8,096.00; E. Powell & Sons, $7,933.06; H. J. Lutes, of Ontonagon, $7,655.50.

BOLLER'S work on Highway Bridges again furnishes us with an illustration of an Iron Bridge, which we have pleasure in presenting to our readers on another page.



IRON HIGHWAY BRIDGE. BY CINCINNATI IRON BRIDGE COMPANY.

THE SCIENCE OF ROAD MAKING.

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 148.*)

The following table gives the effects of various grades on the amount a horse can pull, and is based on calling the load a horse will pull on a level, one:—

Then, on a grade of	1: 100,	a horse can pull		0.90
" "	1: 50,	" "		0.81
" "	1: 44,	" "		0.75
" "	1: 40,	" "		0.72
" "	1: 30,	" "		0.64
" "	1: 26,	" "		0.54
" "	1: 24,	" "		0.50
" "	1: 20,	" "		0.40
" "	1: 10,	" "		0.25

To determine whether it is most advisable to go over or around a hill, all other considerations being equal, we have this rule: Call the difference between the distance around on a level and that over the hill , *d*, the distance around being taken as the greatest, and call *h*, the height of the hill.

Then in case of a first class road, we go round when *d* is less than 16 *h*.

And in case of a second class road, we go around when *d* is less than 10 *h*.

When the height of a necessary embankment gets to be more than 60 or 65 feet, a bridge or viaduct will be found cheaper, and the same measure, 60 feet, applies in case of tunnels, they being cheaper at that depth than open cuttings.

Under the head of laying out roads, something should be said of their width. Speaking only of such roads as are not apt to turn into streets from their proximity to towns and cities, it is well not to make them too broad, for the less the width, the less the cost of construction and maintenance, and a good 23 feet road is much better than a poor one 40 or more feet wide. Each rod (16½ feet) in width adds two acres per mile to the road. An agreeable form of road is to have on each, or on one side of the same a strip, 5 or 6 feet wide, sodded, and then a sidewalk equal in width to one-eighth the width of the roadway. The intervening strip above mentioned, is planted with trees and at intervals of 200–250 feet furnishes storage places, 30 or 40 long, for the materials used in the road repairs. The width of first, second and third class roadways may be given as 26, 18½ and 13 feet, with a tendency during the last ten years to have none, except in the vicinity of cities, wider than 24 feet, and the rest correspondingly narrower. In view of the changes constantly going on in this country in the value and settlement of land, it would probably be well always to *lay out* a road 50 or 60 feet wide, but to *build* the road proper of the width above indicated.

With all these rules and data in mind, the real work of actually laying out the road on the ground and on a map is next in order, and this comes so entirely within the province of the civil engineer, and is a matter requiring so much explanation and study, that it cannot well be introduced within the limits of this treatise. It is in this part of the work that a little skill and labor well spent may be productive of very great saving in the cost of the whole work and it should not be left to the inexperienced or unskilful.*

MAKING THE ROAD-BED.

Under this head are included, earthworks, drains, culverts, bridges, stay walls, etc., etc., all matters requiring a special kind of skill to construct properly. The writer believes it impracticable to write a book which shall at once be interesting to and therefore valued by the public, and of value to the professional man, and thinks an attempt so to do results always in a failure in both directions. True to the determination expressed in the introduction, he proposes, therefore, to treat under this head mainly with those parts of the subject in which the public at large is most interested, for example, the data for the cost of earthworks, general information relating to drainage, bridges, etc.

EARTHWORKS.

The basis of all values is the daily wages of a common unskilled laborer, and in the data given below, this figure, whatever it is from time to time and in various places, must be taken as unity, or the standard measure.

The cost of earthworks may be divided into three parts—(1) cost of loosening the earth, (2) cost of transport, and (3) cost of forming the transported earth into the desired shape. The cost of the first part depends materially on the kind of earth to be handled. The cost of the second, mainly on the distance the earth is to be moved.

*Gillispie, in his treatise on "Roads and Railroads," gives two forcible instances of the amount those roads which might properly be called *chance* roads, can be improved by a road-maker of skill and understanding. An old road in Anglesea, England, rose and fell, between its two extremeties, twenty-four miles apart, a total perpendicular amount of 3,540 feet; while a new road, laid out by Telford between the same points, rose and fell only 2,257 feet; so that 1,283 feet of perpendicular height is now done away with, which every horse passing over the road had previously been obliged to ascend and descend with its load. The new road is besides two miles shorter. The other case is that of a plank-road built in the State of New York between the villages of Cazenovia and Chittenango. Both these villages are situated on Chittenango Creek, the former being eight hundred feet higher than the latter. The most level common road between these villages, rose, however, more than 1,200 feet in going from Chittenango, to Cazenovia, and rises more than four hundred feet in going from Cazenovia to Chittenango in spite of this latter place being eight hundred feet lower. That is, it rises four hundred feet where there should be a continual descent. The line of the plank-road laid out by George Geddes, civil engineer, ascends only the necessary eight hundred feet in one direction, and has no ascents in the other, with two or three trifling exceptions of a few feet in all, admitted in order to save expense. The scenes of similar possible improvements are scattered all over this and the rest of the States; and these facts are still more or equally to be borne in mind in laying out new roads where the ounce of prevention may take the place of the pound of cure.

(*To be continued.*)

RAILROAD COMPETITION.

Sharp competition has again broken out between the trunk railroad lines from Chicago and the Mississippi Valley to the East. Not content with reducing the fare to a point where it is more than doubtful whether any profit remains for the corporations, the companies are rivaling one another in fast trains. In some cases one road gains over another the trifling advantage of landing its passengers in New York an hour or two ahead of competitors. It is well known that trains at high speed are much more detrimental to rolling-stock and permanent way than cars run at a moderate rate, and the slight saving in time, especially when coupled with a reduction in the price of tickets is decidedly the reverse of economical. We should also fear that this shortening of the time table would encourage a certain recklessness in running and in making time when a train was a little behindhand, which would be far from reassuring to the passengers; to be landed in New York twenty minutes or an hour in advance of travelers by another line will not compensate the majority of the passengers for any increased risks.

Since writing the above few lines our eye has fallen upon the following article from the *Railway Age* which is timely and suggestive. It is entitled—

COMBINATION INSTEAD OF COMPETITION.

The hope expressed by the chairman of the Great Western Railway Company, of Canada, at the recent meeting of that body, that "a general combination of railways would succeed the present universal competition," expresses also the feeling of an increasing number of thinking men in this as well as in other countries. The experiment of competition has been tried to the fullest extent in the United States, and with what results? The trunk lines that engaged in the fierce war last year carried freight in enormous quantities at an actual loss, and had those rates continued would ere long have been bankrupted. Meantime they were compelled to the closest economy, resulting in the partial cessation of improvements and additions—thus crippling many branches of manufacture—and in cutting down the pay of their employees and turning many adrift, bringing trouble and want into thousands of homes, and loss into wide circles of business. On the other hand, the transportation business was demoralized by the unreasonably low rates adopted, and the fluctuations and uncertainties which they involved, and now, when an attempt is being made by the railways to recover in part their losses, by asking fair compensation, people refer to the rates paid during the "war," and think that they are being imposed upon. Finally, papers like our neighbor the Chicago *Tribune*, which applauded the destructive competition as a great thing for the shippers, unmindful of the ruin which it was bringing upon railway owners, now turn upon the companies when they increase their charges, and denounce the "outrageous fluctuations in rates," which is the legitimate result of unrestrained competition.

Most of the British railways illustrate the advantages of the opposite plan—combination. There, rates are maintained with general uniformity; the value of railway securities is steady, and the usually very moderate dividends are relied upon with a faith that is seldom betrayed; and while no individual or interest suffers from excessive or discriminating charges, the whole country is benefitted by the prosperity of the railways, and by the absence of injurious fluctuation. Taking a case nearer at home, we may refer to the pooling arrangement of the three great lines between Chicago and Omaha, which has been in successful operation for some six years. There is no complaint, or cause for complaint, that the rates demanded by this combination are extortionate; the service is admirably perfect, and shippers run no risk of loss from sudden and violent changes in rates. The "Omaha pool" is certainly a convincing example of the advantages of fair combination.

After losing millions for their proprietors in costly rivalry the two great Canadian lines, the Grand Trunk and the Great Western, have at last virtually agreed on a working amalgamation which gives hope of the ultimate restoration of these splendid properties. The reform needed by the railway and general business interests of this county is now a similar pooling of receipts by the great trunk lines between the West and the sea-board, and this the managers seem to be seriously considering. Until that is accomplished there will be little confidence in agreements to maintain rates; charges of bad faith will continue to be made by the companies against each other, and the shipping and mercantile interests will be constantly disturbed by rumors that a new "war" is imminent. The country is beginning to recognize the fact that capital invested in railways is entitled to a fair return, fully as much as any other capital, and a combination—restrained by laws, if you please, as it would be by common sense, from excessive and unfair charges—that would give a reasonable certainty that a dividend of say eight per cent. could be depended upon from the great lines, and that the vast amount of securities dependent on the successful working of the lines would have a stable value, would be a blessing to every interest in the country, except that of the gamblers in Wall street.

We have by telegraph a very brief statement of the fall of a suspension bridge at Widcombe, June 6th. Widcombe is in the county of Somerset, England, adjoining Bath on the southeast, and has a population of 10,000. The bridge was over the river Avon, was probably of moderate span, perhaps two hundred and thirty feet, and broke under the weight of some two hundred people. Twenty bodies are said to have been recovered. We are obliged to wait for the foreign papers in order to gain more accurate information.

Measures have been taken to secure to the U. S. Government the desired ground at the head of Davis' Island, near Pittsburgh, in the Ohio River, for the construction of an experimental, movable dam, and the engineers have been directed to proceed with the work. It is thus intended to test the efficiency of such a system, as was referred to in our issue of June 2, for the improvement of the Ohio River. A channel of four hundred feet in width, which can be thrown open at will, is expected to give ample room for the descent of boats with their large tows of coal-barges.

The Sutro Tunnel, which has been prosecuted for eight years, is now advanced about 17,000 feet. The future rate of progress is expected to average 300 feet per month, and some parties estimate that the heading may be expected to strike the Comstock formation in about ten months.

We present herewith the first installment of a very interesting paper from the *Journal of the Austrian Society of Engineers and Architects* upon sewers and sewer building, by J. Chailly, a practical sewer builder, and who takes occasion especially to urge the superiority of cement sewer pipes. Considerable controversy has been held in this country concerning cement versus glazed earthenware pipe, and if the manufacturers and patrons of the former article can gain any fresh information or comfort from M. Chailly's valuable paper on this subject, our publication of the paper will not have been fruitless of good. It is doubtful if much on the subject of sewer building can be said that has not been already touched upon by Baldwin Latham in his Sanitary Engineering; we hope however this paper may be found a valuable appendix to the treatise just mentioned, the publication of which we have recently completed.

CIVIL ENGINEER'S CLUB OF THE NORTH-WEST.

The June meeting will be held at the Sherman House Club Rooms, at 4 o'clock P. M., Tuesday, June 19th.

At this meeting will be held the annual election of officers, and the report of the Secretary and Treasurer for the past year will be presented.

L. P. Morehouse, Secretary.

THE BERGEN TUNNEL.

As this new tunnel on the Delaware, Lackawanna & Western Railroad has lately been completed, and was formally opened on the 12th of May, we add to our former notices the following account and summary of the tunnel and associated works, taken from the *Railway World*, with some additions from the *Railway Review*:

The increase of traffic on the Erie Railway has been so great that at certain hours of the day the Delaware and Lackawanna trains are subjected to vexatious delays at the Erie tunnel. From the day when the celebrated "frog" war was inaugurated at the west end of the tunnel, to the present time, there have been endless disputes between the two companies regarding the right of way. The new tunnel will not only afford speedy accommodation, but will shorten the distance from Hoboken to the Hackensack meadows two-thirds of a mile. The old route has a very abrupt curve at either end of the Erie tunnel, whereas the new route will be a direct line from the depot in Hoboken, a distance of three miles. This will effect a saving in time of ten minutes, besides avoiding the wear and tear incident to curves.

As the new line starts from the Hoboken ferry only a few feet above tide-water mark, it has been found necessary, in order to cross the Erie road at the west end of the tunnel, to carry the new line up a heavy grade. The summit of this grade is at the west end of the new tunnel where it crosses the Erie 300 feet from the entrance, and at an angle of about sixty degrees.

Mr. Archibald, chief engineer of the Delaware, Lackawanna & Western Railroad, presented his report of the completion of the great enterprise to Mr. Samuel Sloan, president of the company, on May 11th. The report, though not lengthy, is very comprehensive. After setting forth the difficulties encountered in the work, the report states that the new route is fully completed and open for traffic. Shafts Nos. 2, 3, and 5 and the "pocket" are yet to be "lined," but the work will not interfere with the running of trains. The survey was made in the spring of 1873, and the contract was awarded on the 20th of August in the same year to Mr. John McAndrew, of Scranton.

The first work done on the great bore was in Sept., 1873, on the eastern side of the hill at a point about due west from the station in Hoboken. The work was prosecuted at both ends simultaneously. It proceeded slowly, and was interrupted several times by strikes and other causes, but in 1873 five shafts were sunk, and 690 feet of tunnel were opened. In 1874 men were at work in all the shafts, and 2,922 feet were excavated. In 1875 the work was continued, and being pushed steadily forward in 1876 on January 18th the last barrier was blown down, and a straight tunnel was opened, though by no means complete. Its roof in many places was found to be insecure, the rocks at many points being friable and likely to tumble when jarred by passing trains, so that it was deemed best to arch a part of them with brick. As a mass of rock had been taken out 27 feet wide and 20 feet high, the company made use of it to build the approaches to the tunnel on the east and west sides. On the east side the broken rock was utilized in grading to the entrance. The approach at the west end is also constructed of rock, so that a firm roadbed is secured. Owing to the yielding nature of the ground, it was found necessary to repeatedly renew the grading, as the rock sank deep into the mud as fast as it was supplied, until the foundation had reached a solid basis. The arching of the interior with brick has delayed the completion of the work, as a much greater part of the tunnel was arched than the engineer at first thought would be necessary. The ventilation of the tunnel will, it is claimed, be excellent, as there are seven shafts varying in size from 27 x 10 feet to 6 x 6 feet, which will constantly serve as drafts to relieve the tunnel from smoke and steam. The entrance on the east side of Bergen Hill is about half a mile north of the Erie Tunnel entrance, but the western mouth is directly over the Erie Tunnel, the tracks of the Erie Railway being crossed by a fine iron bridge.

The grade on the east is thirty feet from the river, ascending to the bridge over the oil track on the Erie, fifteen feet to the mile through the tunnel to the summit over the Erie, where it attains an elevation of thirty-eight and a half feet above high tide. The grade then descends west, on both the main line and the Boonton branch, twenty-six feet to the mile. There are eleven miles of single track in the new improvement.

The tunnel is 27 feet in width and 4,219 feet in length, exclusive of the arch of 35 feet at one end and 25 at the other, making a total length of 4,279 feet, or 100 feet shorter than the Erie tunnel. Nos. 3 and 6 shafts are the full width of the tunnel, and all are surmounted by a brick wall rising to a height of 16 feet above the surface and open on top so that the smoke may freely escape.

It was at first designed to have an open cut at shaft No. 4, which is about midway, to the extent of 300 feet; but this idea was abandoned, and there was constructed instead a large shaft, 27 by 18 feet. Here a signal station may be placed, so that two trains may be run in the same direction at one time, thus doubling the capacity of the tunnel.

The masonry in the side walls is two feet thick and ten and a half feet in height. This is surmounted by a brick arch twenty-two inches thick, covered with felt and asphaltum where there is a chance of water leakage. The space between this and the rock is filled with broken stone and concrete. The arching is carried three-fourths of the length of the tunnel, the remainder being a solid mass of rock, so that no apprehension may be felt in regard to the falling of fragments of rock. A better idea of the extent of the great bore may be formed from the fact that 94,000 cubic yards of rock and 76,000 cubic yards of earth were excavated therefrom. In lining the tunnel 10,000 cubic yards of rock and 500,000 brick were laid (though the contractor estimates the number of brick at millions). The track is of sixty-eight pounds steel rail and the ballast consists of broken stone. The trap rock was found to be difficult to drill but easy to fracture.

The number of men employed in the work was 600 on an average, working in two gangs night and day of ten hours each. Thirteen men were killed, either by falling down shafts, by premature explosions, by being struck with pieces of falling rock, or by being run over by cars, and about a dozen more or less injured. An instance is related of one man who was injured and narrowly escaped death. He was removed to another part of the tunnel, where he was killed a few days afterward.

In constructing the new line from Hoboken to the west side of the Hackensack River it has been necessary to build twelve bridges. These cross Henderson street Grove street, Hoboken avenue, the Erie oil road, the Erie railway at the west end of the tunnel, Duffield avenue, and the Hackensack River. They are all iron bridges, carrying from two to seven tracks. That crossing the Hackensack River is considered one of the finest bridges ever constructed. It is built upon mason-

ry abutments having 1,700 piles for their foundation, and has a draw and two fixed spans, each 200 feet in length. In building the eastern pier, after 300 piles had been driven, the crib which was lowered upon the piles overloaded the foundation, and it was tilted out of place, requiring several weeks of labor to replace it and make the foundation secure.

The masonry and ironwork have won the admiration of all railroad men who have inspected the structure. A canal and dock are being constructed in Hoboken, which will be 600 feet in length and 90 feet in width, so that vessels may be loaded from the tracks on either side.

The cost of the work is as follows:—

Engineering department	$29,000
Land, right of way, etc	875,000
Hackensack river bridge	212,900
Other bridges	349,000
Steel and iron	70,000
Contingencies	68,000
Approaches, east	142,000
Approaches, west	250,000
Tunnel	864,100
Total	$2,860,000

Hypothesis on the Condensation and Re-evaporation of Steam in the Cylinders of Steam Engines. By J. ILLECK.*

The theory of the steam engine, established by Clausius, and developed by Zeuner, stood until lately unopposed, and it appeared that a solution of this difficult problem had been found. The indefatigable labors of Hallauer, Leloutre, and Hirn, however, have within the last few months succeeded in effectively attacking this theory, and in throwing the investigations back to a condition resembling chaos.

In comparing the effective weight of steam at the end of the period of admission, or at any point of the period of expansion, with the feed water required per stroke, a difference will be found to exist, which may amount to from 20 to 70 per cent. According to the older views, this difference is ascribed to condensation of steam in the steam passages (by experiment proved to be very slight in clothed pipes); to leakage of the piston; or to priming water carried over from the boiler; while but little importance has been hitherto attached to condensation of steam in the cylinder itself. Hallauer and Leloutre, however, assume that the boiler steam contains generally not more than 5 per cent. of water in the form of spray; that but little weight need be attached to priming water carried over from the boiler in a coarser condition; and that the steam increases its water content, at its entrance into the cylinder, by condensation against the cylinder walls.

The amount of condensation depends on the ratio of expansion, and on the presence or absence of a steam jacket. Without a jacket it may be 60 per cent. or more; with a jacket it is reduced to about 40 per cent. According to Zeuner, the expansion is adiabatic, and an equivalent decrease of the heat in the steam corresponds to the external work done. For this the mere fall of temperature of the steam only partially accounts, and the remainder is due to condensation. At the end of the expansion, therefore, the amount of steam is diminished, and the water-contents of the cylinder increased. According to Hallauer and Leloutre, the steam, during expansion, takes heat from the cylinder walls; there is re-evaporation, and diminution of the water contained in the cylinder, and part of the heat, given to the cylinder walls during admission, is supposed to be given back to the steam during expansion, when the temperature of the latter has fallen below that of the cylinder walls. In this way they estimate an increase of 40 to 60 per cent. when there is no jacket, and of 55 to 85 per cent. when there is; while the leakage of the piston is neglected.

The greatest difference of opinion, however, exists in the consideration of the period of condensation. According to Zeuner, the steam, with the water contained in the steam, is at the end of the expansion simply driven into the condenser. According to Hallauer and Leloutre, that water is chiefly re-evaporated at the expense of the heat in the cylinder walls. If there is no jacket, the re-evaporation during expansion is not so great as during release, but with a jacket it is greater. To these later views, able though they be, and plausibly though they may explain the excess of the feed water over the theoretical quantity of steam required, the author raises the following objections:—

1. It is inconceivable that in the short time required for admission, so important a quantity of heat as corresponds to the condensation of 55 per cent. of the steam can be imparted to the cylinder walls.

2. It can be shown that the mean temperature of the cylinder walls without a jacket must approximate to the temperature of the steam at the end of the expansion. Under these circumstances it is difficult to see that heat can be given to the steam during expansion.

3. If such a rapid exchange is assumed as possible, it follows that when a jacket is used the cylinder walls must be constantly, throughout their entire extent and thickness, of the temperature of the boiler steam, to secure which the heat supply must be enormous.

Between the return stroke of an engine with a jacket and the admission period of an engine without a jacket there is an analogy, as for both the temperature difference of the walls and steam is constant, and under similar circumstances approximately the same. Between the heat passing from the cylinder to the steam in one case, and from the steam to the cylinder in the other, there must exist a ratio, depending on the mean surface of metal exposed and upon the time. If this be calculated, it will be found that the heat given to the cylinder walls during admission must be very small, or the heat abstracted from a jacketed cylinder during the return stroke would be preposterously large.

4. It appears incomprehensible, why with a jacket the condensation during admission does not nearly vanish. In fact, however, the condensation is about 40 per cent., or only 15 per cent. less than when there is no jacket. This is not attributable to the cooling surface of the piston.

5. That the heat exchange between the walls and jacket cannot be very great is shown by the small condensation in the jacket.

6. If the condensation during admission were merely due to the cold cylinder walls, superheated steam ought to give very advantageous results.

The author then gives his own hypothetical views on the phenomena which occur in the cylinder. He assumes:—

1. The water contained in the steam coming from the boiler is of two kinds: (*a*) Water distributed as fine spray throughout the whole mass of the steam. This from Hirn's researches should not exceed 10 per cent. of the weight of the steam. (*b*) Priming water thrown up by violent ebullition and carried over to the cylinder. This water may be small in quantity, or may reach 60 per cent. of the weight of the steam.

2. The condensation during admission may be partially due to the coldness of the cylinder walls, but a far greater part of the condensation is due to a very different cause. Consider the piston at the end of the stroke and the connection with the condenser established. The steam will pass off into the condenser with the smaller part of the water it contains, which is distributed through it in the form of spray. The greater part of the water in the cylinder remains adhering as a deposit of dew on the cylinder walls. Assume, as a limiting case, that the motion of the piston is very slow. Then, at the beginning of the return stroke, this deposit of dew will have taken the temperature of the condenser, generally in consequence of re-evaporation at the expense of the heat it contains. During the return stroke this water is driven into the clearance space, a great part of it still covering the surface of the piston and cylinder cover. During admission this must, for the most part, be raised again to the boiler temperature, by condensation of part of the incoming steam. The fine dew covering the surfaces of the cylinder probably takes the boiler temperature instantly, while the remainder of the water which lies in a mass, is gradually raised in temperature during the admission, without quite reaching the boiler temperature. The amount of water on the surfaces is not trivial. If it amounted to three times the feed water per stroke, and were uniformly distributed on the surfaces, it would yet form a layer of less than 0.08 inch thickness. Thus the presence of water affords an explanation of the condensation during admission. This water will in future be called the vacuum water (*Leerwasser*) of the engine.

3. The most striking conformation of the existence of vacuum water is found in the phenomena of expansion. Proceeding still with a hypothetical case, let it be assumed that the boiler steam and vacuum water form a mixture of uniform temperature at the beginning of the expansion, and that this mixture expands adiabatically. The expansion of such a mixture when steam preponderates is accompanied by partial condensation, but if the water preponderates, by partial re-evaporation. Now the vacuum water, as has been seen, is greater than the feed water per stroke. Hence, during expansion, there is partial re-evaporation, and this is so considerable that there might be evaporation even when the steam parted with some heat.

4. If the piston moves very slowly, the vacuum water will alternately cool to the condenser temperature, and be heated to the boiler temperature, and the assumption of adiabatic expansion will not be strictly admissible. If the piston moves very fast, the expansion would be adiabatic, but for the circumstance that the vacuum water does not reach the boiler temperature during admission, and the mixture in the cylinder is not of uniform temperature. These considerations make it possible to explain the difference in the action of engines with and without jackets.

In an engine with a jacket there is less vacuum water, and that water more easily adapts itself to the changes of temperature. It is more heated during admission, and more cooled during exhaust; nevertheless the condensation during admission is smaller, because it is determined by the quantity of the vacuum water. The comparison of the two cases during expansion is more complicated. The smaller quantity of vacuum water in the former case (with a jacket) would involve a less re-evaporation, but its higher temperature would lead to a greater evaporation. Probably with a jacket the evaporation during expansion is earlier and more energetic, and, on the whole, greater.

5. The vacuum water is reduced in quantity, but never vanishes. This explains why, notwithstanding the jacket, there is condensation during admission.

6. For moderately superheated steam the vacuum water should be diminished, yet it remains sufficient to reduce the steam to saturation, and to condense part of it. Hence it may happen that moderate superheating leads to no striking advantage. Highly superheated steam ought to do great service, if it prevents the formation of vacuum water.

The author then discusses the action of priming water, and gives a mathematical theory based on his hypothesis.

*Abstracts of Papers in Foreign Transactions and Periodicals. The Institution of Civil Engineers, London.

CORRESPONDENCE.

FORCE OF FALLING BODIES.

NEW YORK, *June 8, 1877.*

Editor ENGINEERING NEWS:

SIR.—Having been shown a republication of a late controversy in the *Scientific American*, on the Force of Falling Bodies, I find that one of the parties has seen fit to adopt my formula therefor, whereupon an opponent is pleased to charge him with being "misled by Haswell," inasmuch as he had attained his result by the formula $W v 4.426 = M$. I therefore feel called upon to defend the party who has confided in me and I submit the following:

Having long entertained the conviction of the error of the ordinary formula for the computation of the impact of a body falling freely; I, in 1852, instituted a series of experiments having in view a determination of the impact by actual operations; for a detailed report of them, see *Appleton's Mechanics' Magazine*, Vol. II, p. 281; the result of which established the following:

1st. *That the dynamical effect, or measure of impact, is directly as the velocity acquired, or, that at the termination of the stroke.*

2d. *That one pound falling freely through a space of 1 foot and having, consequently a velocity of* $\sqrt{1 \times 2g} = 8.02$ *feet per second, had an impact of 35.5 lbs., and that in falling 2 feet, having a velocity of* $\sqrt{2 \times 2g} = 11.34$ *feet per second, and in like manner other weights and at different heights of fall furnished like results.*

$$\text{Hence } \frac{M}{W \times v} \text{ or } \frac{35.5}{1 \times 8.02} = 4.426.$$

A comparison of these results with those deduced by the various formulæ submitted in the discussion, and which embrace all that I recollect to have met with, presents the following,

FORMULÆ.

Weight and height of fall.	Of W. H. P. $W \times h = M$.	Of G. M. T. $W \times v = M$.	Of P. H. Vandervoyde. $W \times v^3 = M$.	Of J. W. Nystrom. $\frac{W \times h}{d} = M$.	Experiment.
	lbs.	lbs.	lbs.	lbs.	lbs.
1 lb. falling 1 ft.	1	8.02	64.33	2	35.5
1 lb. " 2 ft.	2	11.34	122.66	4	50.

W representing the weight of the falling body, *h* the height or space fallen through, *v* the velocity in feet per second, *d* the distance an impinged body, as a nail, would be driven in inches—in this case .5 inches is assumed, and M the effect, or moment of the impact.

In the experiments referred to I did not essay to attain the exact factor or multiplier of the weight, whereby to compute the impact, as I well knew my instrument was not equal to the requirements, but my purpose was to ascertain what was the general relation between velocity and impact, and in this particular I claim to have succeeded; whether the factor was 4.426 or 4.5 times, it matters but little, I had made a successful step in a right direction, and with sufficient accuracy to meet the demands of practical operations.

In consequence of the great variety of formulæ, as presented above, and the confident manner in which they are set forth, I was induced to renew my experiments, which I have done, and I again submit them with a knowledge of their integrity and of the correctness of their deductions.

It is to be regretted that my instrument necessitated the weight to be arrested by a cord, as the tension thereof, was at the expense of the impact of the weight; but in order to remedy this so far as practicable, without the construction of an instrument, capable of admitting the weight to fall freely and to be arrested only at the termination of the stroke; I used cords of hard-laid and long-used fish line, laid up selvagee, and very flexible. What the exact factor is I know not, but my impression is, it must be fully five times the velocity.

Respectfully,

CHAS. H. HASWELL,
C. & M. E.

RICHMOND, VA., *June 11, 1877.*

Editor ENGINEERING NEWS:

SIR.—If *Subscriber*, in your issue of the 9th inst. will make the side walls of his culvert to answer as retaining walls to the side filling around the culvert, he will have accomplished what he needs; but if he persists in using the old fashioned square or box drain, modified by the arch at top, and he really wants economy of material, tell him to examine Rankine, Weisbach or Mosely as texts, or such pocket manuals as Molesworth, Hurst,

and the like, where he will find rules for thickness of arches, of abutments and retaining walls, as well as a limit to the height of abutments, and from these he will determine all the proportions of his culverts.

Very respectfully yours,

ANOTHER SUBSCRIBER.

BOOK NOTICE.

Graphical Analysis of Roof Trusses for the use of Engineers, Architects, and Builders. By CHARLES E. GREENE, A. M., Professor of Civil Engineering, University of Michigan. Illustrated by three folding plates. Chicago: G. H. Frost.

The volume before us consists of a reprint of a series of articles which appeared in our American contemporary, the ENGINEERING NEWS, and although it contains little that is novel, it is well worthy of notice on account of the admirable clearness with which its author has treated his subject. The work is divided into eight chapters, treating respective of general principles; "Trusses under Vertical Forces;" "Trusses with Horizontal Thrusts;" Trusses for Flat Roofs;" "Forces not applied at the Joints;" "Wind Pressure;" "Bending Moment and Moment of Resistance;" and "Load and Details;" and in each section the subject is concisely but completely dealt with. Altogether Professor Greene has produced an excellent little manual which we can decidedly recommend.—*Engineering, May 25.*

PUBLICATIONS RECEIVED.

Report on the Sewerage of the City of Quincy, Illinois, 1877.

Final Announcement of the Woodruff Scientific Expedition Around the World. Indianapolis, 1877.

Annual Report of the Trustees, Secretary and Superintendent of the Toledo, O., Water Works, for the year ending January 1st, 1877.

Journal Zoditchy—Valentin Romanovsky. St. Petersburg, Russia.

Zeitschrift des Oesterreichischen Ingenieur—und Architekten-Vereins. Dr. Wilhelm Tinter. Vienna, Austria.

Transactions of the American Society of Civil Engineers. New York: May, 1877.

NOTES.

Dennis Long, of Louisville, obtained the contract for 20,000 tons water pipes for Cincinnati.

Much discussion has arisen in New York city with regard to the removal of the reservoir on Fifth avenue and 42nd street.

Learners of designing in fancy goods in the institute of Technology, at Boston, are now placed at a loom and required to produce a fabric with their original pattern.

Besides other work on hand, the Novelty Iron Works, Cleveland, are constructing two iron truss bridges, of 165 ft. span each, to be placed across the river at Fort Dodge, Iowa.

The Akron Furnace Company, now erecting works in the Hocking Valley, Ohio, has struck a vein of iron ore from five to six feet deep. They have tunneled for the ore about thirty-five feet on the same plan that is now in vogue for coal mining. Coal in abundance is found in the same hill, and will be used in making iron.

Mr. A. L. Stevenson, an English Mining Engineer, has discovered that blue glass is a perfect test for the presence of gas in small quantities—smaller than can be ascertained by a safety lamp. The yellow flame seen through the glass has a clear white appearance, and the blue cap formed by the gas has a clearer and more striking effect.

A Victoria despatch says a survey of the boundary between Alaska and British Columbia shows that the line intersects Stickeen River eighteen miles from the coast, much nearer its mouth than was supposed, which will enable sea-going steamers to proceed up the river to British territory without detention from American Customs authorities.

E. & A. Betts, of Wilmington, Del., started some weeks ago one of the Walker compound steam pumps at the Chester, Pa., water works. The steam cylinder is 22 in. diam. and the water cylinder 14 in. diam. The lift to the basin is 112 ft. and the distance 1¼ miles; the guarantee was for 800 gallons per minute, but the pump has been frequently exceeding 1,200 gallons per minute.

It may startle some of our readers who have become accustomed to think of India as a land of ever recurring famine, to learn that the Indian export of wheat to England promises at no distant day to make that peninsular continent a formidable rival to our own great West in the English markets. Yet such is the fact. Since Lord Northbrook took off the foolish export duty on grain from India, the grain trade from India to England has risen from 144,441 cwt. in 1871 to 3,279,887 cwt. in 1876. Meanwhile the export from Russia to England has been falling, and India last year sent to England one-third as much grain as Russia and one-sixth as much as the United States. India now stands third in the list of grain. The bearing which this is likely to have on England's final verdict as to her real interest in the Eastern Question is obvious enough.

Captain Howgate, of the Signal Service Bureau, Washington, D. C., has received information to the effect that the merchants of Cincinnati, Chicago, St. Louis, Indianapolis, Milwaukee, Baltimore, Philadelphia and New York are contributing to the fund of $10,000 necessary to procure supplies for the establishment of a colony at Disco for the purpose of Arctic explorations.

The Diamond Hill Quarry Company of Cumberland, Conn., have made a contract to furnish all the stone for the abutments and piers of the Poughkeepsie bridge. The contract is a large one and it will probably require, it is said, two years to complete it, and to facilitate its execution the company are building a branch railroad from their quarry to the Rhode Island and Massachusetts railroad.

At a meeting of the stockholders of the Detroit Locomotive Works, held at the office of the company lately, the following directors were elected: C. H. Buhl, C. Van Husan, John Owen, C. Hurlbut, Cleaveland Hunt. At a subsequent meeting of the Board of Directors elect, the following officers were elected for the ensuing year: President, C. H. Buhl; Vice-President, C. Van Husan; Secretary and Treasurer, D. R. Peirce.

The work of laying the great cables of the East River bridge, N. Y., is progressing rapidly. The wire, having been previously oiled, is carefully wound about a large drum, which holds 60,000 feet of wire. It is drawn across the river by the traveler rope, which is run by steam. The cable wire is carried across in a traveling sheave, and is drawn to the proper height over the river, under the direction of men who are known as regulators, and who stand in the cradles and adjust each wire to the guide wire. The end of each of the small cables is fastened to the "shoes" on both anchorages.

Since the introduction of the Bessemer industry into this country, about ten years ago, the production of steel rails has been as follows: 1867, 2,600 tons; 1868, 7,200 tons; 1869, 9,700 tons; 1870, 34,000 tons; 1871, 38,100 tons; 1872, 94,100 tons; 1873, 129,000 tons; 1874, 144,900 tons; 1875, 290,900 tons; 1876, 412,500 tons. The large increase in the production of these rails last year accounts for some of the depression in the iron trade. The rails produced in 1876 would cover 4,125 miles of track. At the close of the year, there were eleven Bessemer steel works in operation in the United States, including one started last September.

An English paper says: "The new twin steam vessel for the channel service has been launched. She is called the Express, and differs in several respects from the Castalia. The superstructure containing the cabin is supported on an arch, which rises from the inner sides of the two hulls, about thirty feet from each end. This arch is divided in the middle, where the two paddle-wheels, each 24 feet in diameter, are supported. The length of the vessel is about 300 feet, and the width 60 feet. Each hull carries a separate engine with a cylinder 63 inches in diameter and a stroke of 6 feet. The draught of water will not exceed 7 feet, and as the number of revolutions at full speed will be 36 per minute, a high speed for such a vessel is confidently anticipated.

The *Journal Officiel* states that the steam engines in France now give an aggregate of 1,500,000 horse-power, representing a force of 4,500,000 horses, or 31,000,000 men—that is to say, ten times the valid industrial population (the industrial population of France now amounts to 8,400,000 inhabitants—women, children and old people included, among whom can be reckoned only 3,200,000 active workers). The first engine which appeared in France came from Boulton and Watt's works, at Birmingham, in 1789, and was used for distribution of water to the city of Paris. It was not till 1824 that large works for construction of steam-engines were begun. Some idea of the great comparative progress of the last thirteen years may be had from the fact that in 1852 there were 6,000 fixed steam-engines in France, representing 45,000 horse-power; in 1863, 22,500, representing 618,000 horse-power; the number at present being as stated above.

The committee, consisting of Sir John Hawkshaw, Colonel Yolland and Mr. Barlow, appointed by the Board of Trade to consider the practicability of assigning a safe coefficient for the use of steel in railway structures, and the correspondence connected therewith, have made their report. They recommend that the employment of steel in engineering structures should be authorized by the Board of Trade under the following conditions, namely. (1) That the steel employed should be cast steel, or steel made by some process of fusion, subsequently rolled or hammered, and that it should be of a quality possessing considerable toughness and ductility, and that a certificate to the effect that the steel is of this description and quality should be forwarded to the Board of Trade by the engineer responsible for the structure; (2) that the greatest load which can be brought upon the bridge or structure, added to the weight of the superstructure, should not produce a greater strain in any part than 6½ tons per square inch. They remark that cases may arise when it will be proposed to use steel of special make and tenacity, and when a higher coefficient than the above might be permissible, but they think those cases should be left for consideration by the Board of Trade when they arise.

Speaking of the economy produced by the use of steel rails on the line of the Grand Trunk Railway of Canada, the London *Colliery Guardian* of May 4, says:

"The experience of the Grand Trunk in the matter of steel rails must also be the experience of the Great Western of Canada, the Northern, the Midland, and other Canadian railways. The fact has been established beyond the possibility of doubt or criticism that steel rails, and steel rails alone, can enable Canadian railways to withstand effectually the rigors of Canadian winters. It is not, however, equally clear that all the steel rails which may be laid down in future upon Canadian railways will be ordered in England. On the contrary, so far from this being the case, even now we find that in 1876, out of 79¾ miles of steel rails laid down upon the Grand Trunk Railway of Canada, only 32 miles were supplied from England. In 1875, out of 155 miles of steel rails similarly laid down upon the system, 99 miles were supplied from England. Here we have another illustration of the growth of American metallurgical industry and of American competition.

RAILROAD NOTES.

The Wheeling and Lake Erie narrow gauge railroad is so far completed that trains are now running between Milan and Norfolk, Ohio.

The C. T. V. & W. Railway Company, of Ohio, have obtained the right of way for their extension to Wheeling, and the construction of the balance of the line will commence immediately.

The great railway tunnel through the Pyrenees, which will save twelve hours of diligence riding in the journey from France to Spain, is expected to be completed by January next.

The work of locating the extension of the Lake Erie Division from Jarvis, Ont., to Port Dover, of the Hamilton & Northwestern R. R. has been begun and it is expected that twenty miles will be built this year.

The survey of the route for the Stroudsburg and Wind Gap railroad, Pa. has just been completed. The road will run from Stroudsburg to Bethlehem, a distance of eighteen miles, six miles of which have already been graded ready for the rail.

The Grand Trunk R. R. authorities, Canada, are considering the project of removing their works from Brockville and Belleville and centralizing them at Kingston, as well as running their trains into the heart of the city. Kingston is holding out large inducements.

The highest point yet attained by any railroad in this country has been reached on the summit of Lavetta Pass, in the Sangre de Christo Mountains, by the southwestern extension of the Denver and Rio Grande Railroad, Col. The altitude at the summit is 9,340 feet.

Considerable interest is taken in the new project to build a narrow gauge railroad from Washington Court House via Hillsboro, as near the Gore survey as practicable, to the Ohio river at Ripley, thence crossing the river at Maysville. It will there strike the unfinished Maysville and Big Sandy railroad, connecting with Lexington, Kentucky.

Somebody has perpetrated the following on Captain Eads work on the Mississippi: "Those willow mattresses at the mouth of the Mississippi make the bed of the river more comfortable, to be sure. But still the shipping don't lie there nearly as long as formerly. If they are bound to New Orleans, they 'get up' as soon as possible."

The recent railroad surveys in San Diego and San Bernardino counties, California, have established some curious facts about the Colorado dessert. The lowest point surveyed is 278 feet below the level of the sea, and the lowest point on the line of the Southern Pacific Railroad is 275 feet. From a point near Indian Wells, for 60 miles east toward Yuma, the whole road lies below sea-level. An old ocean beach, clearly distinguishable, extends all around the edge of this immense basin, at a level some fifteen feet lower than that of the sea. Immense beds of salt have been found, in some cases two feet thick. Analysis shows this salt to be almost pure chloride of sodium.

Articles of association of the Ohio Falls, Terre Haute & St. Louis Narrow-Gauge Railroad Company were filed on June 11th; capital stock, $1,000,000; shares of $50 each, with the privilege of increasing said sum from time to time to a sum equal to the cost of constructing said railroad reserved. Directors, D. F. Whitcomb, J. H. Gardner, W. H. Irvin, E. B. Whitcomb, W. H. Ongley, E. Camp, P. Miller, and Samuel Coner. The line commences near the Falls of the Ohio, in the County of Clark, running thence through the Counties of Floyd, Scott, Washington, Jackson, Lawrence, Green, Owen and Clay, and terminating at Terre Haute, with a branch road commencing at some point on the main line in the County of Washington, running through the Counties of Washington, Orange, Martin, Daviess and Knox to East St. Louis, a distance of 250 miles, with another branch road leading from some point on the main line in the County of Jackson, running to Brownstown, a distance of fifteen miles, said railroad to have a total length of 415 miles.

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 140.*)

$$\frac{k}{c^3}\left\{y_0(5c^3-cb^2)+\frac{y_1}{2}(c+b)^2(3c-b+\frac{y_2}{2}(c-b)^2(3c+b)\right\}=$$
$\frac{14}{15}k^3c$, or

$$2c(5c^2-b^2)y_0+(c+b)^2(3c-b)y_1+(c-b)^2(3c+b)y_2=\tfrac{28}{5}kc^3. \quad (15.)$$

67. It is not necessary to integrate in order to obtain equations from the other two conditions, although they may be derived quite simply in that way. The second condition may be written

$$\Sigma EF=\Sigma(DE-DF)=0, \text{ or } \Sigma DE=\Sigma DF.$$

ΣDE is the summation of all of the ordinates to the arch, or the included area between the rib and the line AB. The area of a parabolic segment being equal to two-thirds of the rectangle of the same base and altitude, this area will be $\frac{2}{3}.2c.k$, or $\frac{4}{3}ck$. ΣDF will be the summation of all of the ordinates to the two inclined lines, or the areas of the two trapezoids, giving $\frac{y_0+y_1}{2}(c+b)+\frac{y_0+y_2}{2}(c-b)$, or $cy_0+\frac{c+b}{2}y_1+\frac{c-b}{2}y_2$. Equating these two values, we obtain

$$2cy_0+(c+b)y_1+(c-b)y_2=\tfrac{8}{3}ck. \quad (16.)$$

The condition that $\Sigma EF.DB=0$, or that $\Sigma(DE-DF)DB=0$, gives

$$\Sigma DE.DB=\Sigma DF.DB,$$

and this condition is satisfied by the equivalent step of multiplying each area, just obtained, by the horizontal distance of its centre of gravity from one abutment, the right one for example, and equating the products. The left hand member will then plainly be $\frac{4}{3}ck.c$, or $\frac{4}{3}c^2k$. A simple way to determine the centres of gravity of the trapezoids will be to divide them into triangles by drawing lines from G to the extremities of the ordinates y_1 and y_2, when the centre of gravity of each triangle will be at one-third of the distance, from the ordinate which forms its base, to wards the vertex. This gives

$$\frac{y_1}{2}(c+b)[c-b+\tfrac{2}{3}(c+b)]\ \frac{y_2}{2}(c-b)\tfrac{1}{3}(c-b)+\frac{y_0}{2}(c+b)]\ c-b+\tfrac{1}{3}$$
$$(c+b)]+\frac{y_0}{2}(c-b)\tfrac{2}{3}(c-b, \text{ reducing to}$$

$$\frac{y_1}{2}(c+b)\frac{5c-b}{3}+\frac{y_2}{6}(c-b)^2+\frac{y_0}{2}(c+b)\frac{4c-2b}{3}+\frac{y_0}{3}(c-b)^2.$$

Equating the two members and clearing of fractions, we find that

$$2c(3c-b)y_0+(c+b)(5c-b)y_1+(c-b)^2y_2=8c^2k. \quad (17.)$$

68. Equations (15.), (16.) and (17.) contain the three unknown quantities. The eliminations may be performed as follows:—

Multiply (16.) by $c-b$, obtaining

$$2c(c-b)y_0+(c+b)(c-b)y_1+(c-b)^2y_2=(c^2-bc)\tfrac{8}{3}k.$$

Subtract from (17.)

$$4c^2y_0+4c(c+b)y_1=(2c^2-bc)\tfrac{8}{3}k. \quad (g.)$$

Multiply (17.) by $3c+b$,

$$2c(9c^2-b^2)y_0+(c+b)(15c^2+2cb-b^2)y_1+(c-b)^2(3c+b(y_2=(3c^2+bc^2)8k.$$

Subtract (15.) and divide the remainder by $2c$,

$$4c^2y_0+6c(c+b)y_1=(\tfrac{14}{3}c^2+bc)4k. \quad (h.)$$

Subtract (g.)

$$2c(c+b)y_1=(\tfrac{44}{15}c^2+\tfrac{4}{3}bc)k,$$

$$y_1=\tfrac{2}{15}\cdot\frac{c+5b}{c+b}k. \quad (18.)$$

Substituting this value in (g.) or (h.), we get

$$y_0=\tfrac{8}{15}k, \quad (19.)$$

and by analogy, or by substitution,

$$y_2=\tfrac{2}{15}\cdot\frac{c-5b}{c-b}k. \quad (20.)$$

These three values are the desired ones; y_1 and y_2 are similar, as we should expect; for, when a load is moved from one side of the centre to an equal distance on the other, y_1 and y_2 change places. Therefore it must be remembered that y_2 is the value of the ordinate at that springing which is nearest to the weight. If the load is in the middle, $b=0$, and $y_1=y_2$. It is worthy of notice that y_0 is a constant quantity for all positions of the weight. These ordinates can be easily computed for a weight at different points, and it will be seen that a value of b greater than $\frac{1}{5}c$ will make y_2 negative, or to be plotted below the springing line. The original reasoning showed, and the above equations will prove, that the third condition may be taken about the other abutment and will still give the same values for the ordinates.

69. If we propose to work out data for use with this kind of arch also, we must calculate first the values of y_1 and y_2 for all points. Let a rib be divided into ten parts, equal horizontally as before. Then, if $b=nc$, we may write

$$y_1=\tfrac{2}{15}\cdot\frac{1+5n}{1+n}k; \quad (18'.)$$

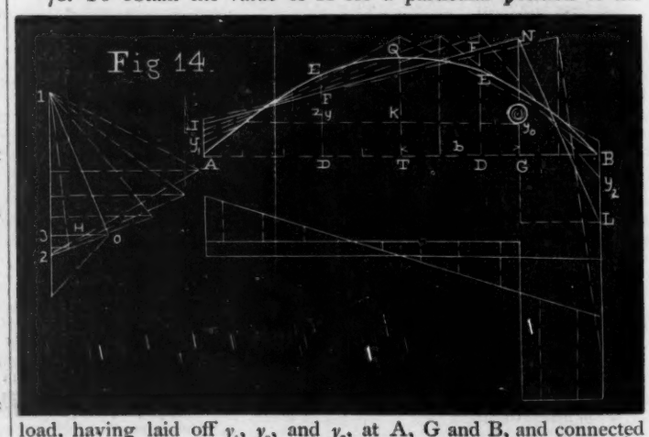
$$y_2=\tfrac{2}{15}\cdot\frac{1-5n}{1-n}k. \quad (20'.)$$

VALUES OF y_1 AND y_2.

$n=\frac{b}{c}=$	0	.2	.4	.6	.8	
$\frac{1+5n}{1+n}=$	$\frac{1}{1}$	$\frac{2.0}{1.2}$	$\frac{3.0}{1.4}$	$\frac{4.0}{1.6}$	$\frac{5.0}{1.8}$	
$\frac{2}{15}\cdot\frac{1+5n}{1+n}=$	0.1333	0.2222	0.2857	0.3333	0.3704	$k=y_1$
$\frac{1-5n}{1-n}=$	$\frac{1}{1}$	$\frac{0}{0.8}$	$\frac{-1.0}{0.6}$	$\frac{-2.0}{0.4}$	$\frac{-3.0}{0.2}$	
$\frac{2}{15}\cdot\frac{1-5n}{1-n}=$	0.1333	0	−0.2222	−0.6667	−2.0	$k=y_2$

The computation is shown in the above table, which is so similar to previous ones as to call for no explanation. Only remember that y_1 and y_2 change places for loads on the left of the crown. The curves for one half the arch are shown in Fig. 14.

70. To obtain the value of H for a particular position of the



load, having laid off y_1, y_0, and y_2, at A, G and B, and connected their extremities, we draw 1–0 and 2–0 parallel to N L and I N, from the extremeties of the weight 1–2, and then draw 0–3 for H. The vertical components of the abutment reactions will be 2–3 and 3–1. If we draw the horizontal dotted lines from I and L, we shall have similar triangles to those in the stress diagram, and we may write

$$y_0-y_1:c+b=(2-3):H, \text{ or } H\frac{y_0-y_1}{c+b}=(2-3)=P_1$$

$$y_0+(-y_2):c-b=(3-1):H, \text{ or } H\frac{y_0-y_2}{c-b}=(3-1)=P_2=W-(2-3).$$

Substitute the value of (2—3) from the first equation, transpose, and obtain

$$H=\frac{W}{\frac{y_0-y_1}{c+b}+\frac{y_0-y_2}{c-b}}. \quad (21.)$$

WOODRUFF SCIENTIFIC EXPEDITION.

The final announcement of the Woodruff Scientific Expedition around the world has just been issued. We published the prospectus in our number for February 17, with a description of the proposed route. The expedition has been gotten up by James O. Woodruff, of Indianapolis, Ind., who has chartered the screw steamship "City of Merida" of the New York, Havana and Mexican Mail S.S. Line. She was built in 1870, is 256 feet long, 1500 tons burthen, and first-class in every respect. She will be under the command of Commander John W. Philip, U. S. N., with whom will be associated Lieut. Com. A. S. Crowninshield, U. S. N., and Lieuts. Hutchins, Rhoades and Miller, U. S. N., besides a full complement of other officers and crew.

Professor Burt G. Wilder, of Cornell University, a well-known geologist and comparative anatomist, is at the head of the faculty; and Prof Wilder, Com. Philip, Dr. Herdman, Gen. Macauley and Prof. Jenney are to be the trustees of the expedition, to hold the funds accruing from fees, and to see that the Director fulfills his agreement and obligations before the monies are paid over to him.

Other members of the faculty are Prof. Schafiter, of Berne, Switzerland; Farlow, of Harvard University; Jenney, of University of Michigan; Smith of Yale College; Taylor, of Phillips Academy; Herdman, of University of Michigan; and Russell, of Columbia College; also Mr. Ives, of Cornell University, photographer; Dr. Kidder U. S. N., ornithologist; Mr. Corwin, of Cornell and University of Michigan, taxidermist, etc.

The route will be from New York to the Amazon, thence down the coast of South America, through the Straits of Magellan, to Valparaiso, thence to Sydney, Australia, by the way of the Society and Feejee Islands; then by the Solomon Islands, to Formosa, Japan, China, Borneo, Batavia, Singapore, Calcutta, Ceylon, Bombay, the Red Sea, Suez Canal, Egypt, the Mediterranean, and so on round to London and back to New York. The date of sailing is fixed for October next, and the time of absence two years. The expenses are put at $5,000, which cover a number of specified inland excursions, while others can be made at the private expense of the excursionists.

The expedition will probably be recognized and approved by the U. S. Government, thus insuring many advantages in foreign ports. It starts out under most favorable auspices, with the cordial endorsement and good wishes of our leading scientists, and we can confidently expect such additions to our knowledge of the geography, archæology, geology, fauna and flora of the regions visited, many of which are very little known, as will redound to the credit of all connected with the enterprise. Valuable scientific collections will be made, each portion being the private property of the collector, and the steamship affording ample room for their transportation. There is an admirable opportunity now open to colleges or other public and private institutions, desirous of enriching and adding to their museums, to pay the expenses of some young lover of science who shall collect for them in return for the privileges of visiting these countries.

The pamphlet before us gives other valuable instructions for which we have no space, but copies of it, as well as any additional information, can be obtained from the Secretary, Daniel Macauley, Indianapolis, Ind.

THE rainfall of the past fortnight has been sufficiently great and widespread to raise the level of the Western rivers very decidedly; some of them have not been higher for years. The outpouring of their floods should have such an effect upon the Mississippi, that the scour at the head of the South Pass and between the jetties should be maintained and increased; thus aiding and encouraging our brethren who are working hard to create there a deep water channel.

IT appears that we were quite in error when we suggested that the reported suspension bridge, which recently fell at Bath, England, might have been some two hundred and thirty feet in span. It is now stated to have been a narrow, wooden bridge, of light construction, about *thirty* feet long, resting upon posts morticed into stonework at either end, and from thirty to forty feet above the River Avon. On the occasion of the arrival of a train load of excursionists, between one hundred and two hundred persons rushed upon the bridge, probably packing it full, when it snapped in the centre and the whole structure with the people was precipitated into the water. The moving load under which the bridge failed, must have approached, if it did not exceed, one hundred pounds to the square foot, imposed with considerable shock. This load is no greater that bridges of moderate span should be designed to carry with safety.

IT is a very easy matter to tie a bridge truss to the abutments by anchoring bolts, but we surmise that it is seldom done. In case the bolts are not built in to the masonry, they can be readily carried down the face of the abutment and entered horizontally, in a drill hole at a sufficient distance below. This precaution should always be taken with wooden bridges, which are generally covered completely, as in such cases a sudden violent wind or a hurricane, like that which destroyed the covered bridge over the Connecticut River, between Northampton and Hadley, Mass., on June 14, has a very great overturning moment about the bridge seat. We recall the case of a Howe truss railroad bridge, similarly taken from the abutments by a strong gust of wind, just in season to allow a locomotive to plunge into the chasm, the driving rain which accompanied the wind preventing the engineer from seeing that the bridge was gone.

That a covered bridge is liable to this class of accident, will be a good reason, if the truss is bolted down at the ends, for inserting the counter-braces of a Howe truss in all of the panels, but, as the dead weight of the bridge acts against the lifting power of the wind, the counters need be of only moderate size.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 75th regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on Tuesday, June 19th, President Chesbrough in the chair.

After approval of the minutes of the preceding meet-meeting, a ballot took place for the election of the following gentlemen: Messrs. E. C. Carter, C. S. Seyton, and Geo. D. Ansley, City Surveyor of Montreal, Canada, who duly became members of the Club.

The secretary reported the following donations:

"The rate of set of metals subjected to strain." Prof. R. H. Thurston, Hoboken, N. J. From Genl. A. A. Humphreys, Chief of Engineers. eight documents published by the War Department concerning "Improvement of Mouths of Mississippi River" and other Internal Improvements, and Vol. 6—Report on Geological Exploration of the 40th parallel.

This being the appointed evening for the election of officers for the ensuing year, and the report of the Secretary and Treasurer for the past twelve months, the Secretary presented and read the report.

An invitation having been received from the members of the Club at Springfield, Illinois, Messrs. Nichols and Clark, to hold the annual meeting in that city, which however, could not be accepted, a vote of thanks was unanimously passed and ordered to be sent to those gentlemen.

The ballot for the election of officers then proceeded, Mr. Chesbrough, the retiring President, and Mr. Morehouse withdrawing from the candidacy.

The following gentlemen were elected for the year 1877–78.

President—Genl. Wm. Sooy Smith, C. E.

Executive Committee—S. S. Greeley, C. E., and B. Williams, C. E.

Secretary and Treasurer—L. P. Morehouse, C. E.

Votes of thanks were tendered to the retiring officers, who replied in brief speeches, and also to the proprietors of the Sherman House for the use of the Club Room of that hotel.

An adjournment then took place until the first Tuesday in September.

The New York Central and Hudson River Railroad Company have been experimenting for some time past to discover how long a locomotive can be run with due regard to economy, without repairs. It is found that locomotive No. 90 has run 70,000 miles in eleven months without going to a repair shop.

THE METRIC SYSTEM.

BY HOSEA PAUL.

PAPER NO. I.

One of the great questions of the day is, whether or not the metric system shall be adopted. Able minds have discussed it in many ways; paragraphs, communications, editorials, pamphlets, and even books have been written on the subject, and still the end is not yet; and so far, the great mass of people ordinarily classed as well informed, not only have very little knowledge of the new system, but scarcely more of the systems for which it is put forward as a substitute.

As to what is essential to a perfect system of measurement there has been some difference of opinion. Many writers have dwelt strongly upon the necessity of having a unit of measurement that should be in no respect arbitrary, but derived from, or supplied by the magnitudes of natural objects; such for instance as man in a primeval or savage state possessed of neither tools or instruments, would come in contact with. In this way, small objects may be measured by grains of wheat, the distance between the knuckles or joints, or the length or breadth of the fingers, or of the hand itself.

But the requirements of savage life, with its limited range of comparisons, is easily met, and a different unit or standard is used for each class of objects, the magnitude of which they desire to describe. One animal may be compared with another. A dog, for instance, may be considered as twice the size of a cat, and an elephant as being the size of a given number of horses. The faculty of using large numbers being generally wanting among the uncivilized races, it is impossible for them to conceive the relation between a finger length, and the distance an arrow can be shot from a bow; or between an arrow's flight and the distance that a man may traverse in a day's journey. Each of these, and similar units, serve their turn as a convenience for measuring a certain class of objects; and while it might be seriously argued that for the purpose of estimating certain distances a system whose unit was a pace of 28 or 29 inches would be in every respect more natural and convenient than any now in use, the trouble still remains. What might be convenient for a savage, or man without tools or instruments of precision to determine distance, might not offer any particular advantage to civilized man in measuring cloth, or in giving dimensions of parts of machines.

Civilized man has use for definite knowledge, and has occasion to compare and measure a thousand things where the savage has one, and it is no longer practicable to have a thousand separate standards. Increased facility in reckoning makes comparisons possible, and thus unnecessary and superfluous standards are gradually eliminated, and now, when the systems of expression are vastly simpler than they were a few centuries ago, it remains to decide whether the good work should continue; whether a further simplification is not both possible and desirable.

There has been much ingenious speculation as to whether the unit chosen as the base of the metric system is all that could be desired. In our opinion it did not greatly matter whether the one selected was an inch, a foot, a pace, a yard, a metre, the length of a pendulum, the flight of an arrow, or a day's journey. One would have answered about as well as another. We believe that a universal unit is, necessarily, an arbitrary one, and therefore, should have no prejudice against the metric system, even though it should be fully demonstrated by the more perfect processes of science, that a metre is not, exactly, one ten millionth part of the distance from the equator to the pole.

The metric system is, indeed, based on an arbitrary unit, but it takes the place of those not less so. It is desirable because it substitutes one unit for many. Take our common expressions: an inch, a yard, a chain, are they not wholly arbitrary? Can any one tell what an acre is? If a blind man were to go into an open field on a dark night, and, without counting his steps, set stakes or otherwise mark off at hap-hazard a space to include an area which should be used as the unit of measuring land, it would be as convenient a unit as an acre is. Can every surveyor even tell off-hand how many feet, rods or chains form the side of a square containing an acre? We think not. So inapplicable were the ordinary units, a new one, a chain, or rather a link, was devised by Gunter, expressly to render more easy the computation of areas expressed in acres—a meaningless unit of area being retained at the expense of introducing a new and incongruous unit of lineal measure.

There are many who, while they have some appreciation of the many advantages of the metric system, hesitate to advocate its adoption on the ground that it would disturb much that is now fixed, while the change would be a difficult one to make. If it could be shown that the present practice of expressing lengths of boundary lines and of areas is now uniform and consistent, certainly no other system should be substituted unless vastly better. But there is a great diversity in this respect. In Pennsylvania, for instance, the practice is to state distances in perches and tenths, and the custom a common one to "throw in" six per cent. for roads, it requiring $160\frac{6}{10}$ perches to make an acre, and on this acre, in some parts of the State, at least, land is bought and sold, taxes levied, etc.

ON THE USE OF FASCINES IN THE PUBLIC WORKS OF HOLLAND.*

BY THOMAS COLCLOUGH WATSON, M. INST. C. E.

Holland, from its geographical position, is exposed both to damage from the sea and to internal inundation. Lying at the outlet of the rivers Rhine and Meuse, for a great part many feet below low water, the inhabitants have been engaged for centuries in a continued contest with the waters. In this struggle the Dutch have had to contend with no ordinary difficulties: their country produces no stone, timber, or other material usually employed in great hydraulic works; while the soil is composed of soft alluvium, brought down by the rivers, and deposited on a base of sand which formed originally the bed of the ocean.

While Holland produces none of the materials referred to, its swamps and morasses are admirably suited to the growth of the willow, alder, aspen, and brushwood of analogous character. This has been taken advantage of; hence nearly all the vast protective works of the country derive their strength from the judicious employment of fascines. The object of this paper is to show how, with their aid, the Dutch have succeeded in protecting their country, not only from internal inundation, but from the ravages of the ocean itself.

FASCINES,

Called in Dutch, "Ryshout," are derived from copses of willows, osiers, etc., on the low lands and islands in the estuaries of the Rhine and the Meuse. Willow, with a small admixture of ash and alder, is grown as a business, the crop being cut every third or fourth year.† The wood is cut early in the autumn as a rule, but in cases of extraordinary demand in the spring. The cutters are careful to leave the stub, or root, with an oblique upper surface, having its highest point towards the north; neglect of this precaution is said greatly to lessen the succeeding crop.

There are several sorts of ryshout: Hollandsche, Brabantsche, Geldersche, Limburgsche, Schornesche, and Gasterlandsche, so called from the different provinces where the wood is grown. Fascines of oak and hazel are procured from the higher districts, but the wood generally used is willow.

"Hollandsche ryshout" is of this latter wood, very full of small branches and twigs, the main sticks growing tolerably straight and parallel. The largest are used for cask-hoops; the smaller are cut and tied in bundles. Each bundle contains at least three sticks 9 feet 10 inches to 11 feet 6 inches long, and two of 6 feet 7 inches to 8 feet 2 inches; the twigs and smaller branches remaining attached to the sticks, which are about 1¼ inch in diameter at the root end. If the branches are insufficient, more brushwood is added; the whole is bound round with two osiers, one being about 1 foot from the thick end, the other 3 feet from the top; the bundle, when complete, should measure about 17 inches in circumference at the thick end, and about 14 inches at the other. These faggots form the great base of all fascine operations, and their cost is from 5*s.* to 7*s.* per hundred according to demand. Fascines should be used within a year of their being cut; if kept longer they lose much of their strength and toughness.

"Haring band," or "Tuin latten," are sticks of about ¾ to 1 inch in diameter, without twigs or branches, made up in bundles of twenty-five; they are straight, tough willow, and their cost is from 22*s.* to 30*s.* per hundred bundles.

"Hollandsche garden," or latten, resemble the former except that the branches are allowed to remain; they are thinner and longer—8 feet 10 inches to 9 feet 10 inches—made up in bundles of forty each, secured by osiers.

"Wiepbanden," "Kruisbanden," and "Knypbanden," are osiers to be used as withes or binders; they are respectively 4 feet 3 inches, 5 feet 3 inches, and 6 feet 7 inches long, and their cost is from 3*s.* to 6*s.* per thousand.

"Palen," or "Staken," are stakes of willow or alder, about 6 inches in circumference in the middle, 4 feet 5 inches long, and have a sharp three-cornered point; these are made up in bundles, containing ten each, at 24*s.* to 30*s.* per hundred bundles.

"Sliaten" are heavier stakes than the foregoing, being 7 inches in circumference, and 7 feet 3 inches long.

"Dyk horden" are close watcled hurdles, consisting of thirteen vertical equidistant stakes, interwoven with pliable willow sticks about ¾ inch in diameter.

The above completes the list of Hollandsche ryshout; that derived from other provinces is of much the same description, differing only in an admixture of oak, hazel, ash, and other brushwood.

Oak piles, called "Perkœn palen," are also used in fascine works; they are about 5 feet 3 inches long, and 1 foot in circumference in the middle. Two sorts of reeds are used in protecting slopes from the wash of water under fascines: "Groenriet," cut when green, called also "Bladriet," made into bundles 8 feet 2 inches long and 2 feet in circumference; and "Dekriet," cut when come to maturity, made up into bundles 6 feet 7 inches to 9 feet 10 inches long, and 3 feet 3 inches in circumference.

The materials above described are all produced in the country; but as large quantities of stone are required on nearly all fascine works, either as ballast to submerge the fascine mattresses, or as paving on slopes permanently exposed to wash, basalt from the Rhine is chiefly used, while Norwegian granite and Belgian limestone are also employed.

HOW THE FOREGOING MATERIALS ARE MADE USE OF.

The duties of the Dutch engineers, so far as protective works are concerned, consist mainly in constructing, with the foregoing materials, dams to restrain rivers within certain channels; to protect slopes or foreshores; to dam off river branches, or tidal estuaries, and to reclaim land. As an instance of the latter, the following description is given of the mode adopted in closing an estuary of the Zuiderzee, east of Amsterdam, called "Het Y," under the author's supervision:—The width at the point selected for the construction of the dam was 1,367 yards, about ¾ mile; the depth of water varying from 5 feet to 27 feet. The bottom was soft alluvium, about 40 feet deep, reposing on sand. There was a rise and fall of tide of about 14 inches; variations in level from storms reached 10 feet to 15 feet, at which times the current was 2½ miles per hour, although usually not more than half that velocity. At 328 yards from the northern end, locks and sluices were constructed in the body of the dam, taking up about 394 feet of its length. The following is an extract from the specification: "The crown of the dam is to be 13,1 feet broad, rounded 9.8 inches, carried to 12.3 feet above A. P. (Government standard level, called Amsterdamsche Peil, being the datum of reference all over the Netherlands): the external slope facing the sea to be 3½ to 1 to 1.64 foot above A. P., and the internal slope to be 2 to 1 to the same level; then a horizontal berm 9.8 feet wide on the outside, and another 16.4 feet wide on the inside, and next slopes of 2 to 1 to 1.64 below A. P.: if fascines are used, slopes below this level to be ¾ to 1.

"The slopes, berms and crown are to be covered with puddled clay 3.28 feet thick; both sides to be protected with strong fascine works from the top to 1.64 foot below A. P., and loaded with stone. When the dam is closed, the fascines on the inside and outside slopes are to be removed; a bed of broken bricks, 0.66 foot thick, is to be placed on both slopes, and the surfaces paved to 1. 64 foot below A. P., with stone at least 1 foot thick.

In commencing the construction of the dam (dyke in Dutch), the first step was to cover the entire site with a strong fascine mattrass, worked in pieces 197 feet long, and overlapping each other about 3 feet 3 inches, called "grondstukken"; then to build up the exterior dams entirely of fascines to low-water level, nearly filling the trough or hollow between them with sand or clay.

As fascines under water are nearly always used in the form of "grondstukken" or "zinkstukken," a detailed account of their construction is necessary.

The first requisites for a "grondstuk" are the "wiepen"; these are ropes of fascines, which form a network above and below the gronkstuk, constructed as follows:—The workman drives two stakes into the ground, about 2 feet 6 inches apart, to which he secures a cross stick about 2 feet 3 inches from the ground. A series of these frames are erected about 2 feet apart, the number being dependent on the size of the grondstuk and consequent length of the rope, or wiep. The stage being ready, those bundles of fascines with most branches and twigs are opened and the contents placed on the cross sticks of the stage, the fascines being drawn out lengthwise, so that each bundle overlaps and bonds well into the next. They are laid of such thickness that, on being bound round in the form of a rope, the circumference is 17 inches. When the full length for one weip has been laid out, they are tied with osier bands, "knypbanden," at intervals of 1 foot 3 inches. The bands are tightly twisted and the ends tucked under like a faggot band. Lighter intermediate bands, "weipbanden," are then put on about 4 inches apart, and the rope, or weip, is ready. The wiepen are now laid out on the ground in parallel rows 2 feet 6 inches to 3 feet 3 inches apart, to the full width of the proposed mattrass. These are crossed by a second layer at right angles to the first, thus forming a network with meshes 2 feet 6 inches to 3 feet 3 inches square, the exact size of the projected grondstuk.

The site for making the grondstuk should be between high and low-water mark, for convenience of subsequent floating; they are, however, frequently prepared on the surface of the water. Every alternate crossing of the wiepen is securely tied with ½-inch tarred rope, the ends of which are left about 4 feet long, and temporarily secured to stakes thrust vertically in the wiepen. The other crossings are secured by "kruisbanden" of withe. The crossings on the two external rows are generally lashed with rope.

The lower network, being now complete, is covered with a layer of ryshout one bundle thick; a second course is laid across the lower one, and a third at right angles to the second, the three layers being about 18 inches thick. A corresponding network of weipen is next laid on, and fastened to the lower by the rope ends described as being left over, and they are secured to temporary stakes.

In order to sink and hold the mattrass, it is loaded with a bed of stone. To prevent this rolling to one side in sinking, or on a sloping bottom, the upper surface of the grondstuk is thus divided into rectangular cells: stakes, "palen," are driven into the crossings of the wiepen and all round the edge of the grondstuk; between these "tuin latten" are interwoven or wattled three sticks together. When the wattles are about 7 to 9 inches high, the palen are driven down into the mattrass,* the ends remaining about 6 inches above the wattle-work, called "tuinen," the cells formed by which serve not only to retain the ballast in place, but add greatly to the strength of the grondstuk.

The "proppen" are mooring posts, by which the grondstuk is towed to its destination, and held by cables and anchors before sinking. The position of these is decided on when the lower weipen are being laid, and always at a crossing. The wiepen are there worked much thicker, and securely bound with tarred cord on each side of the crossing, as well as to the upper wiepen. A large and heavy stake is now driven through the mattrass, and six or seven others in a sloping direction, radiating from the centre one. The wiepen are sometimes strengthened at the crossing by a bundle of tuin latten being lashed to the weipen at the crossing, instead of being thickened. The proppen so secured cannot give way without tearing the grondstuk. The mooring cables are simply turned two or three times round the proppen, so as to be easily cast off when the grondstuk is sunk.

The mattrass, now ready for submersion, is towed to its place and loaded with stone so as just to float. Anchors are placed on all sides, as many as may be necessary to retain it (dependent on the velocity of the current), the time chosen being about half an hour before the turn of the tide. Small vessels of from 10 to 15 tons' burthen are secured to the edges of the grondstuk by ropes running under the upper weipen, both ends being fast on board the barge; other vessels, with fresh supplies of stone, being kept in reserve outside. The ballast is first carried by men standing on the mattrass towards the centre pockets, and worked toward the outer edges. When the mattrass begins to sink in the centre, and the strain on the supporting ropes becomes severe, a halt is called for a few minutes, while the crews of the barges pile up the remaining cargo on the side of the ship towards the mattrass. This weight, with the tension on the ropes, gives the boats a considerable list; but, being built of great beam and stout, they resist. At a given signal every captain stands by the supporting rope; and at a second signal, all the ropes are let go simultaneously, the crews throwing out the stone as rapidly as possible, to keep down the outer edges of the grondstuk, which might otherwise be turned and rolled up by the current. The vessels meet near the centre of the mattrass, which now lies on the bottom. The ballasting proceeds until a load of about 3½ cwt. to 7 cwt. per square yard has been deposited as nearly as possible over the whole surface.

"Zinkstukken" are made and sunk in a similar manner, the difference being merely in name. The first zinkstuk is that which reposes on the bottom, hence called "grond," or ground piece, the successive layers are called "zink," or sinking pieces.

The grondstukken are made to overlap each other lengthways. Those used in the Amsterdam dyke were 2 feet 6 inches in thickness. Including stone, the cost was as under, per metre:—

	Fl.	*Cents.*	*s.*	*d.*
Twenty bundles fascines at 4.50 f.	0	90	1	6
Thirteen stakes, ½ bundle latten	0	11½	0	2½
Wiep and kruis bands	0	5	0	1
Spun yarn, or tarred rope	0	5	0	1
Labor, making, and sinking	0	16½	0	3½
	1	28	2	2

To which must be added the cost of the stone, 200 kilogrammes [nearly 4 cwt.] of basalt 1*s.* 8*d.*, raising the whole to about 3*s.* 3*d.* per square yard. Prices have, however, augmented since the dam was made in 1866; the same work would now cost at least 4*s.* 3*d.* per sq. yard.

Although the substratum of fascines will not prevent sinking in soft ground, this takes place regularly and gradually; but danger is incurred by the possibility of the grondstuk being too weak to carry the weight of the bank in the centre of its cross section, and in consequence being torn asunder longitudinally. When this happens—as it did in the case under consideration—there is nothing to be done but to add material until a solid bottom is reached. The bank, on splitting lengthways, the two parts being supported by the halves of the torn grondstuk, move laterally, as the cavity in the centre is filled and sunk. It was at first intended to have used a double grondstuk; but the idea was abandoned from the fear of water penetrating the bank between the fascines. In sandy ground there is no danger of this, as in a few days the sand completely chokes up the interstices, and a solid bank is the result.

It will be apparent that working up the two side dams, from the bottom to near the surface of the water, by successive layers of fascine mattrasses, was a simple and easy method of closing the water-way. The last length of 328 yards of opening was raised over the whole distance simultaneously. Further, the material of the core, chiefly sand, was contained securely, none being washed away by the current. Many instances can be adduced where this mode of working has been most successful: at the Sloe, a branch of the Scheldt, for the passage of the Flushing railway; the approaches to the great Moerdyk bridge; and many places on the Lower Rhine, in all which cases a rapid current and considerable variation of tidal level were encountered.

(To be continued)

* A Paper read before the Institution of Civil Engineers, London

† A hectare (2½ acres) will produce about four thousand to five thousand bundles of fascines, besides stakes and hoop wood.

CORRESPONDENCE.

MACOMB, ILLS., *June 14, 1877.*

Editor ENGINEERING NEWS.

SIR.—If it should be necessary to re-establish a section in the interior of a township where all traces of the old corners are obliterated, would it be correct to commence at interior known corners in adjacent towns, north, south, east, and west, and run lines through and divide *pro rata*? Or should the corners of the town in which the land is located be re-located and then divided *pro rata*?

This query is proposed upon the supposition that different towns were originally surveyed by different hands, and with instruments of varying standards of both course and distance. B.

FERRYSBURG, MICH., *June 9, 1877.*

Editor ENGINEERING NEWS:

SIR.—I see, in looking over the account of the "Hantrigon" as given in ENGINEERING NEWS of April 22d, 1876, page 133, by Mr. Greene, that though the instrument has won his "admiration," it has not won his full understanding of its principles.

In the "astronomical triangle," whose several sides are co-altitude, co-latitude, and co-declination, azimuth is *never measured*, except at the zenith-angle, *i. e.*, at the intersection of altitude arc (A.) with the latitude arc (L) at the zenith of the observer—[see figure on page referred to], whereas Mr. Greene represents it as measured at the position-angle—*i. e.* at the angle occupied by the object (as the sun or stars) observed upon.

The error of the azimuth thus measured might vary indefinitely between zero and 90°, from the inclination of the meridians, due to latitude and difference of longitude.

This oversight, or erroneous representation, will prevent young students from getting a clear idea of that beautiful instrument.

Moreover, I would suggest that the altitude arc be changed, end for end,, with regard to the graduation, to correspond with the vertical circle actually used in measuring the altitude: *i. e.*, set the 90° point at the zenith of the observer, then the reading for altitude will be *on the object*, as it should be.

The arrangement as given in the figure, would be like reading a leveling staff wrong end up.

Yours truly, H. C. PEARSON.

ST. CHARLES, MO., *June 15, 1877.*

Editor ENGINEERING NEWS:

SIR.—In your notice of DuBois' translation of Dr. Weyrauch's last book you ask your readers to inform you how much and where the formula

$$\text{Cross-section} = \frac{\text{max. B} + \text{max. B'}}{10.000}$$

is used in this country.

The foregoing form of the expression is so changed that I doubt if it is used by any American engineers, but the principle involved, that of providing separately for tensile and compressive stresses in the same member, has been recognized in the constructions of my associates and myself for eleven years past, and I presume the same can be said of Albert Fink, Frederick Vaughan, and Jos. Wilson, in all of whose structures compressed tensile members are to be found.

In St. Charles bridge—designed in 1867—the formula used was—

$$\frac{\text{max. comp.}}{S} + \frac{\text{max. tension}}{10.000} = \text{cross-section},$$

S = strength of member in pounds per square inch by Rankine's Gordon formula—factor 4.

This formula answers well where the opposing strains are nearly equal, but where they vary greatly a modification is required. This is effected by changing the factor of safety for the compressive strain, care being taken that this factor shall not be less for the combined sections than is given by the formula—

$$4.+(\frac{H-15}{10}) \text{ in which } H = \frac{l}{d}.$$

C. SHALER SMITH,
Baltimore Bridge Co.

PUBLICATIONS RECEIVED.

Catalogue of the State University of Iowa, for 1877.

The July *Atlantic* may perhaps be called a hot weather number. The first paper is the beginning of a humorous story by T. B. Aldrich, called "The Queen of Sheba," which introduces characters whose names the reader has heard before, and the reviews in Recent Literature take up "The American" and other novels. Between the beginning and the end of the number are a travel sketch by W. D. Howells, "At the sign of the Savage;" a characteristic story, "Freedom Wheeler's Controversy with Providence," by Miss Rose Terry Cooke; a paper on wood-life entitled "Recreation and Solitude," by W. J. Stillman, and one of Edgar Fawcett's poems, "Fireflies," a subject which seems to belong to him. General Garfield gives a historical paper entitled "A Century of Congress," with practical suggestions drawn from his own experience; Edward H. Knight continues his illustrated papers on "Crude and Curious Inventions at the Centennial Exhibition"; there is an article suggested by Paige's "History of Cambridge," and Professor James Russell Lowell has a sonnet, "Nightwatches." The Contributors in their Club discuss The American, the Old South, Municipal Junketing, Fechter, Anastasius, new pictures, new books, and the unfailing Boston culture. The range of this unique department grows wider every month.

The July number of *Harper's Monthly* has come to hand, profusely illustrated, interesting as usual, and containing the following: "On a Naughty Little Boy, Sleeping—Bret Harte; "Snow Banners of the Californian Alps"—John Muir; "The Wreck of the Fishing-boat"—J. T. Trowbridge; "The Mohawk Valley During the Revolution"—Harold Fredric; "Westminster Abbey"—Lyman Abbott; "The Cloud"—a poem—John B. Tabb; "A Beautiful Charity"—A. P. C.; "A Woman-Hater"—Part XIII. (*Concluded*)—Charles Reade; "Northern Islands"—Edwards Roberts; "Dawn"—a poem—Ellis Gray; "Hunting with the Long-bow"—Maurice Thompson; "Birds' Nests"—H. D. Minot; "Stronger than Death"—a poem—Elizabeth Stuart Phelps; "Barnaby Pass"—a story—Constance Fenimore Woolson; "Erema; or, My Father's Sin"—R. D. Blackmore; "Auf Wiedersehn"—a story—Augustus Stevens; "Our Civil Service"—F. H. Morse; "Amurath IV., A. D. 1638"—a poem—George Lunt; Editor's Easy Chair; Editor's Literary Record; Editor's Scientific Record; Editor's Historical Record; Editor's Drawer.

TRANSMISSION OF POWER BY SHAFTS AND ROPES.

The power lost by transmission from the prime motor to distant work is a matter of great importance. Our readers will be interested to know that the advocacy of ropes for transmission, to which we have formerly alluded in these columns, is still maintained. At the recent meeting of the English Society of Engineers, Mr. H. Robinson read a paper in which the following points were made. As regarded the transmission of power by shafting, etc., the results of several experiments and calculations showed the loss to be from 32 to 37 per cent. The application of ropes as a means of transmitting power at Oberusel, near Frankfort-on-the-Main, at Logelbach, in Alsace, at Schaffhouser-on-the-Rhine, and at Fribourg-on-the-Saane, was next described. The loss of power by transmission by a single wire rope was estimated to be about six per cent. It has been stated that the cost of ropes was only one-fifteenth that of an equivalent amount of belting, and only one-twentieth that of shafting. The wear and tear of ropes, together with the necessity of avoiding steep inclinations where the distances were long, lessened the advantages of that system. On the other hand, the loss of power in transmission by ropes, varied only as the velocity, whereas either by compressed air, or by water, the loss due to friction increased as the square of the velocity. The application of rope gearing to transmit the power from the prime mover to machinery in a factory, in substitution of toothed gearing, was also mentioned.—*Min. and Sci. Press.*

NOTES.

A Tramway is about to be constructed over the Portage at Grand Rapids, Canada, for the Hudson Bay Company. This will, it is said, greatly facilitate the navigation of the Saskatchewan. No aid is asked from the Government.

Parties of engineers left Winnepeg, Ontario, on the 15th inst., to stake out the Pembina branch railway between Selkirk and St. Boniface, and a large force of workmen is expected to be at work thereon next week.

Mr. C. F. Alysworth, engineer of the Colonization Roads of Ontario, was at Mattawa, Canada, lately, making measurements for a bridge over the Mattawa river, which is to be constructed this season. The probability is, that a road to the foot of Temiscamangue Lake will be commenced next season.

The G & S. W. R. R. (Narrow Gauge) proposes to build an extension of twenty miles this year. The road is now in operation from Galena to Platteville, Wis., thirty-one miles. The extension leaves the main line four miles southeast of Platteville and ends at or near Montfort, Grant Co., Wis.

On the 13th inst. the Board of Asylum Commissioners, Pontiac, Mich., awarded the contract for furnishing the steam-heating apparatus and engines, etc., to Andrew Harvey & Son, of Detroit, at $35.763.46, but since that time a question has been sprung hinging on the action of the legislature, which has changed very much the mode of procedure and caused the Messrs. Harvey to withdraw their acceptance of the job. The Board of Commissioners asked for an appropriation of $82,000 to complete the work, and figured their estimates to the lowest possible sum, and gave an exceedingly small margin for contingencies, which the appropriating committees of both houses plainly saw, and both committees recommended an addition of $5,000, and reported to appropriate $87,000. The bill as it passed, however, had been cut down to $67,000, and had tacked it to this proviso, in substance, that no part of this appropriation be drawn from the State treasury until an abundant supply of living water be supplied upon the grounds for all purposes of the institution. This proviso acted as prohibition to letting a contract to be paid from the new appropriation until a supply of water was provided, and when the Messrs. Harvey ascertained how matters stood they withdrew from the field unless the State would pay interest upon the contract until paid. This, of course, the Board could not guarantee.

The Walworth Manufacturing Company, of Boston, Mass, has proposed to complete the works at $37.332.07 and carry the expense until a supply of water was provided, and a contract was entered into with them on the 16th inst. to that effect.

The Government of India have determined to make extensive alterations in the rolling stock of Indian railways, so as to make it equally useful for military and commercial purposes. 5 per cent. of the third-class passenger carriages are to be made available as ambulance cars, all the covered goods wagons are to be made available for the transport of horses, and the ordinary ballast wagons are to de altered in such a way that guns may be easily placed upon them. The cost will not be less than a quarter of a million.

The work on the Hudson River Bridge is progressing rapidly, about 150 men being constantly at work. The first caisson draws now (May 21) 47 feet of water, and is within about 12 feet of the bed of the river. Courses of timber are being added to it at the rate of about three feet per day. The second caisson has been launched, and is also rapidly progressing. A third gang of men is employed in arranging the ways for the third caisson, so as, if possible, to avoid the trouble which has been experienced in launching the other two. A fourth gang is employed in getting the derricks and purchases up ready to hoist the stone for the piers, the first load of which will shortly arrive from the quarries in Rhode Island.

The *American Manufacturer* says:—The work of laying two of the four great cables of the Brooklyn bridge is now in progress. The steel billets out of which the wire of these cables is manufactured, are from the works of Messrs. Anderson & Passavant of this city (Pittsburgh), and, as delivered, are drawn to a fourth inch in thickness. The work of preparing the wire from these billets is done at a manufactory in Brooklyn. Before being galvanized this wire measures 165-1000 of an inch in diameter. Before being sent to the bridge it is galvanized and receives two coats of oil, increasing the diameter to from 168-1000 to 173-1000, weighing in coils of from 800 to 1200 feet not less than 60 pounds. On the anchorage the wire receives another coat of oil, and is wound on to drums in lengths of about 10 miles, the wires being spliced, and from them is paid out and brought to the New York anchorage by means of the carriers.

The cables, of which there will be four, when complete will consist of 19 strands of 330 wires each. It is thought that one strand for each cable can be completed in one month, at which rate it will take nineteen months to finish the cables. The cables will measure about 15½ inches in diameter, and weigh some 800 tons each.

The San Francisco *Call*, of the 29th ult., gives this information as to the Canadian Pacific. A party of Canadian engineers arrived in this city last evening on their way to Victoria to resume the work of locating the line of the Canadian Pacific Railroad. The line, as laid down by Sandford Fleming, runs from Montreal through the Dominion of Canada to Sault Ste. Marie; thence around Lake Superior, skirting the northern shore to Manitoba on the southern end of Lake Winnipeg; thence, trending northward, through British Columbia on the thirty-third parallel, crossing the Rocky mountains at an altitude of 4,300 feet, and striking the Guif of Georgia in the neighborhood of Bute inlet, about two degrees further south.

About one-third of the route has been located, including that portion from Montreal to Sault Ste. Marie, and a few hundred miles both east and west from Manitoba. The length of the line from Montreal to Bute inlet is 2,322 miles, and will shorten the route from England to Japan about 900 miles. The country through which the road will pass is in a comparatively unsettled state, but the building of this trans-continental line will develop immense resources in this region, and open up to trade and agriculture a large tract of country now almost valueless on account of inaccessibility. It would appear, at first thought, that the severity of the climate would be a serious obstacle to the success of this project, but the engineers state that the snow will not cause as much trouble on the Canadian Pacific as it now does on the Central Pacific.

The Central Pacific crosses the mountains at an elevation of 8,242 feet, nearly double that of the Canadian Pacific, the highest point of which is but 4,300 feet above the sea level. This is evidently an immense advantage for the latter, both in building and maintenance of the road, and will do away with the necessity of constructing extensive snowsheds. This project was first broached in the Canadian Parliament over thirty years ago by Hon. Mr. Young, who was regarded as the wildest kind of a lunatic in consequence. The Dominion Government has recognized the value of such a road, and it is more than likely that Mr. Young will live to see the completion of an iron highway through British America, in realization of his chimerical ideas of thirty years ago. A large carrying trade between England and Japan will be developed by this route in consequence of the comparatively short distance by rail.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 156.*)

We find by experience, that in digging and loading or throwing 5–10 feet horizontally with a shovel, we obtain for different materials the results of the following table:—

Number.	KINDS OF EARTH.	In Parts of a Laborer's Day's Wages			
		Cost per cubic yard to loosen.	Cost per cubic yard to load in wheelbarrows.	Cost per cubic yard to load in carts or wagons	Amount to be added for keeping and repairing tools.
1	Loose earths, which are loam, sand, etc., inclusive of loading	$\frac{1}{12}$–$\frac{1}{9}$	–	–	$\frac{1}{16}$
2	Heavier earths, such as sticky clay, which does not readily leave the shovel, etc.	$\frac{1}{9}$–$\frac{1}{4}$	$\frac{1}{16}$	$\frac{1}{18}$	$\frac{1}{16}$
3	Earths which must be loosened with a pick before they may be shovelled	$\frac{1}{4.5}$–$\frac{1}{3}$	$\frac{1}{16}$	$\frac{1}{18}$	$\frac{1}{16}$
4	Solid banks of gravel or clay, earths containing boulders, etc., in which one man only loosens as much as another man shovels	$\frac{1}{3}$–$\frac{1}{2.5}$	$\frac{1}{16}$	$\frac{1}{18}$	$\frac{1}{14}$
5	Same material, worst kind, brick and mortar heaps, earth full of roots, etc., in which it takes two men to loosen what one man shovels	$\frac{1}{2.5}$–$\frac{1}{2}$	$\frac{1}{14}$	$\frac{1}{16}$	$\frac{1}{14}$
6	To break up stone which is in layers or seams, requiring the use of the crowbar only, but no blasting	$\frac{1}{2}$–$\frac{1}{1.5}$	$\frac{1}{12}$	$\frac{1}{14}$	$\frac{1}{12}$
7	Blasting rocks in an open cut, according to the hardness of the rock, to the position of the seams, etc.*	$\frac{1}{1.5}$–$\frac{1}{1.25}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{10}$
8	In forming and shaping embankments	$\frac{1}{1.25}$–$\frac{1}{0.75}$	$\frac{1}{10}$	$\frac{1}{12}$	$\frac{1}{10}$

*To excavate rock to a given line and level, that is, to trim a cutting may cost double these figures per yard.

TRANSPORT OF EARTH.

Throwing with a shovel.—This is to be done only from 5–12 feet in distance or from 5–6 feet vertically. To throw 5 feet vertically, costs as much as 12 feet horizontally, that is to say, if 30 feet horizontally cost per cubic yard, one day's wages divided by 8.4 the same distance vertically will cost about 2½ times as much, or more exactly, one day's wages divided by 3.5, whence is seen the economy of using windlasses, etc., instead of "stages,"† in shoveling earth vertically. The table gives the cost of shovelling earth certain distances, expressed in the number of cubic yards a laborer's day's wages will pay for.

Distance of Throw in Feet.	Vertical or Horizontal.	Whether done at one operation, or by means of so-called "stages."	Number of cu. yds. which can be transported at the cost of one laborer's day's wages.	Remarks.
0–10,	Horizontally,	No "stages."	23.5	Wheelbarrow cheaper.
10–20,	"	1 stage.	12.6	
20–30,	"	2 stages.	8.4	
0–5,	Vertically,	No stages.	14.1	
5–10,	"	1 stage.	8.8	

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

† By a "stage" is meant the operation of one shoveller lifting and throwing what another has thrown in front of him.

Wheelbarrows.—The usual distance of transport suitable for the use of wheelbarrows is 100-200 feet. In exceptional cases it may be more, but perhaps never above 500 feet and then only for moderate quantities. In going up hill, the greatest inclination is to be not more than 1 in 10, and a man can push only ⅔ as much on this inclination as on a level. 3 feet vertical transport costs as much as 90-100 horizontally. Whenever possible, planks should be laid for the wheel-barrows to run on. The best timber for this purpose is beechwood and the cost of keeping such planks is only about $\frac{1}{40}$ or $\frac{1}{50}$ per. cent. of the cost of transport per cubic yard.

Distance of Transport in Feet.	Number of trips per day of ten hours, made with one man at barrow, and one to load.	Contents of wheel-barrow load in cubic feet.	Number of cubic yds. which can be transported at the cost of one laborer's day's wages.
10–20,	120	2½	23.5
20–50,	110	2½	16.9
50–70,	100	2½	14.4
70–100,	93	2½	13.8
100–150,	96	2½	13.3
150–200,	94	2½	12.8
200–250,	92	2½	12.4
250–300,	90	2½	12.0
300–350,	88	2½	11.6
350–400,	86	2½	11.2
400–450,	84	2½	10.9
450–500,	82	2½	10.5
500–550,	80	2½	10.2

PATENT PORTABLE RAILROAD AND HAND-CARS.

These have lately been introduced in this country, and appear to be coming into general use and favor. The company owning this improvement, as it seems to have a right to be called, claim, that by means of their track and cars, which can be used everywhere that a wheel-barrow or a horse-cart can go, and in a great many places where these vehicles cannot go, they affect a very large saving, as much in some cases as ⅞ of the cost by the other means of transport. There are no data published as yet to make tables from similar to the foregoing; from the company's pamphlet, however, one given case which occured on Staten Island in 1867, may be analyzed and tabulated as follows:—

Distance of transport, in feet,	550
Number of trips per day of ten hours, with one man at two cars, and two to load,	150
Contents of car in cubic feet,	11.34
Number of cubic yards which can be transported at the cost of one laborer's day's wages,	60

ONE-HORSE CARTS.

The table for this kind of transport may be stated about as follows. 1 foot vertical costs as much as 14 horizontal.

Distance of Transport in feet.	No. of trips made per day of ten hours, assuming only four minutes to load, dump, &c. per trip.	Contents of cart load in cubic feet.	Number of cubic yds. which can be transported at the cost of a laborer's day's wages.
300,	86	8	17.1
500,	67	8	13.6
1,000,	43	8	8.6
1,500,	31	8	6.4
2,000,	25	8	5.0
2,500,	21	8	4.3
3,000,	18	8	3.6

Ox-cart transport is 10 or 12 per cent. cheaper than the above, but takes more time.

Other methods of transport, such as horses or engines on temporary tracks, would hardly ever be applied to road-building, but belong more properly under the head of railroad construction.

SHRINKAGE.

In calculating the cost of earthworks, the so-called shrinkage of earth must not be overlooked. Earth occupies on the average $\frac{1}{10}$ less space in embankment than it did in its natural state, 100 cubic yards, shrinking into 90. Rock on the contrary, occupies more space when broken, its bulk increasing by about one-half.

The shrinkage of gravelly earth and sand may be taken at 8, of clay 10, loam 12, surface soil 15, and of "puddled" clay 25 per cent. The increase of bulk of rock is 40 to 50 per cent.

(*To be continued.*)

THE ERIE CANAL.

Buffalo, as well as the boatmen and that portion of the State of New York which feels directly interested in the prosperity of the canals, has been much exercised as to what will be the future of the Erie Canal. The commerce upon it has declined very greatly since 1873; the shipment of grain in that year was fifty million bushels, falling to twenty-seven million bushels in 1876. This decline has been due to the prevailing hard times, assisted by competition among railroad lines.

The introduction of steam haulage in one form or another has been advocated as a panacea for the evil and the reduction of tolls has also been urged. There is no doubt but what steam can be successfully and economically applied, as it has been demonstrated by the Baxter, the Rapid, and other boats on the Erie Canal, by steamers and barges introduced upon the Illinois & Michigan Canal, and by experiments elsewhere. The difficulty seems to be that sufficient freight does not offer. While a reduction of tolls and charges will doubtless increase the proportion of grain which goes by water instead of by rail, there is no use in attempting to work the canal at such a low rate that a loss shall result. The railroads have the advantage in speed, and in the absence of danger of heating and melting on a long voyage.

A pamphlet upon the Erie Canal: "What can be done to save the Commerce?", shows the cost of transporting wheat from Buffalo to New York, including tolls and covering expenses of the return trip to Buffalo.

	Cts. per bushel.
Boats towing in line	7.6
Boats towing with their own teams	6.6
Baxter steam canal boat	6.
Boat towing Belgian cable	5.4
Canal Steamer Rapid	5⅛
Steamer Rapid with consort	4.8

It will be remembered that the State of New York offered in 1871, a prize of $100,000 for the best application of steam power to the propulsion of boats on the canals of the State, each power to be adapted to the boats at present in use. By reason of this offer the Baxter steamers and others were brought out, but although the Baxter boats were complimented, the commissioners made no award. The *Buffalo Express* says:

Afterward the State legislature, by special enactment, granted $5,000 each for ten steamers to be placed on the canal, seven to be like the Baxter steamer and three like the steamer Newman. These were constructed in accordance with the law, and the State paid the $50,000. It appears this bonus did not result as intended, in the permanent establishment of steam propulsion on the canals, as the canal line of steamers organized on the basis of the subsidy did not prove a success. The boats of that line have been out of commission since the close of the season of 1875. About the only steamer that appeared on the canals last season was the Rapid, a new boat with improved wheel and other improved devices, which came out the latter part of the season, and which is represented to have demonstrated greater speed, combined with a larger carrying capacity, and more economy in running expenses, than any of its predecessors. There is some talk of forming a company to place a line of these steamers on the canal. It is proposed to run with each steamer a barge as consort, to be pushed ahead of the steamer instead of being towed astern in the usual manner, the carrying capacity of the two to be 15,600 bushels of wheat. On account of the stringency of the times, and especially the misfortunes of the Baxter line of steamers, capitalists do not look upon the enterprise with great favor, and unless some encouragement can be obtained from the State in the way of a bonus or slight rebate of toll, based upon the tonnage transported through the canal, there is little prospect of enlisting the desired capital.

One of our exchanges writes:

It may be said by cavillers that the Baxter system has utterly failed. This is not so; the company has failed, but this does not prove that the principle is wrong. The large original outlay, and the weakness of the company, its mode of doing business, the small carrying capacity of the boats, the delays occasioned along the canal and locks, the jealousy of horse boatmen, and many other causes, *but not the use of steam*, have occasioned the insolvency of this line. Again, this is no argument against encouraging steam, for the Rapid system, so far as tried, is successful, and from all experiments and reports, and the knowledge we have of the Belgian Cable system, it also gives a promise of great things. So, too, the argument that the Baxter Company has failed would not avail against the claims of steam as a motor, for the most careful calculation, allowing everything in favor of horse-boats, shows that the cost of carrying by steam is much less than by animal power.

A canal boat of the usual size can carry from 1,100 to 1,200 barrels of pork or beef, or 2,000 to 2,100 barrels of flour. The time of trip from Buffalo to New York by mule power is from ten to twelve days; by steam-power, six to eight days. While last year the canal rate of freight was nine cents per bushel on corn, which is stated to have been a large reduction from previous charges, the boatmen have now reduced the freight on corn between Buffalo and New York, to four cents per bushel. As the lake vessels are taking corn from Chicago to Buffalo for two cents, and the total cost from Chicago to New York is now about seven and one-half cents, if the boatmen do not obtain business enough, it will be evident that low rates will not secure the desired commerce. The rate by cases is about 16¾ cts. per bushel. If the canal does secure the business, we fear that it will only grow poorer under the above rates. The cost of the canals built by New York has been in excess of the revenue, and therefore the best way of utilizing them is of great interest to the State.

THE Ohio canals were built by that State and have been a continual source of expense. In 1861 they were leased to private parties for an annual rental of about one-tenth of one per cent. on their cost. The lessees have notified Governor Young that, in a certain contingency, they will abandon their lease of the public works. The contingency referred to has already risen, namely the filling up of the basin of the Miami Canal, at Hamilton, O., and drawing off the water of the same. This the city is doing under the authority of an act of Legislature. It is certain that if the works are abandoned the business interests of various portions of the State will be seriously impaired.

THE METRIC SYSTEM.

BY HOSEA PAUL.

PAPER NO. II.

Whether the practice of requiring more than 160 perches to make an acre is met with outside of Pennsylvania, the writer is unable to say from personal knowledge. The denominations, rood and furlong, though given in text books, and "drilled into" the pupils of the public schools, are not only nearly obsolete among surveyors, but by everybody else. The terms rod, perch and pole, are, it is said, all of English origin. The writer has observed that the term *rod* is used in New England, *perch* in Pennsylvania, and *pole* in the South; but there are probably so many exceptions that it would be difficult to name a locality where one term was used to the exclusion of the other. Probably the term rod is of the most extensive use, at least colloquially, and here it may be said, that chains and links are as foreign to the comprehension of most people as metres are; they are emphatically a surveyor's measure, used for measuring land, and for no other purpose, and therefore rods, yards, or even feet are better understood. Hence, in nearly all amateur surveying,—and there is an immense amount of it, especially in the smaller villages, and the small tracts surrounding them—distances are expressed in rods. When it comes to denoting distances less than 16½ feet, these would-be surveyors are all astray. Sometimes a rod is divided decimally, but oftener into some other fraction. If they use a surveyor's chain (Gunter's) they are apt to use rods and *links*. If a common pole is used, rods and *feet* are the denominations. If, again, as is often the case, care is not taken to clearly state what particular unit is used, we are often left in great uncertainty as to what was intended.

The great majority of land surveyors throughout the Western States use Gunter's chain, and it is, in the older states, gradually superseding rods, poles and perches; and also, what is of some consequence, and a step forward towards a decimal system, fractional parts of an acre are expressed decimally, in hundredths (or in thousandths if necessary), instead of in roods and perches, as was formerly the custom.

But while the use of chains and links is convenient and desirable where *areas* are to be dealt with, and while the use of them for this purpose is becoming more general every year, their use is falling off in another direction. In England and its colonies, engineering surveys are made with a 66 feet chain, and following this practice, in most of the early turnpike and canal engineering of this country, distances were expressed in chains and links, but of late years, in nearly all engineering surveys and surveys of lots and streets in cities and towns the practice has been to substitute feet and tenths to the exclusion of all other units.

Where areas are to be expressed in acres, the use of a foot unit is, however, exceedingly awkward, and involves considerable extra labor; so much so, that to make its use convenient a new unit of square measure, say 10,000, or 100,000 feet, would have to be adopted. It is a pity that Gunter's ingenuity had not been spent in this direction, still more so, that it was thought necessary to save a meaningless unit of area at the expense of introducing a new, and incongruous unit of lineal measure.

A large portion of the Western States was once under control of France; other parts, notably Texas and California, was at a very recent period Spanish territory, and to a considerable extent the use of French and Spanish measures is kept up the present day.

The use of a double set of units, feet and chains is exceedingly inconvenient in many ways. Take, for instance, the width of streets. Why is one street laid out 49½ feet wide while the width of another is 50 feet? There is, ordinarily speaking, no good reason why they should differ six inches. It is a clear case of different chains, rods (or links) *versus* feet. So obvious are such discrepancies, it is the custom of many surveyors, though using chains and links to denote distances, to actually lay out streets, and alleys, as so many feet wide, expressing the width in the nearest half link, *e. g.*, eighteen links for twelve feet; 45½ links for 30 ft; 68 links for 45 feet; 76 links for 50 feet; 91 links for 60 feet, and 151½ links for 100 feet. But this is not always attended to, and hence the different unit causes unnecessary and awkward discrepancies. An alley laid out with Gunter chain is, say, 20 or 25 links wide, $13\frac{80}{100}$ and $16\frac{50}{100}$ feet respectively; if the survey is made with a 50 or 100 ft. chain, the alley is more likely to be 14, 15, or 16 feet. Similarly, we find, instead of 50 links, 30 and 35 feet; in place of 75 links, 50 feet; 60 feet instead of 66; 80 and 85 in place of 82½, and 100 feet instead of 99. Indeed, consider the subject in the best light we may; get rid of, as we are doubtless doing, rods, perches, furlongs, roods, varas, toises, yards and what not, we have still left chains and feet; two units, each having certain advantages for certain purposes, but continually interfering with each other. They are, certainly, neither of them, in any sense, a popular measure; for a chain is only understood by the general public when it is translated into four rods, and while a foot is one of the most familiar of units, yet not one person in a hundred has any conception of a considerable distance expressed in feet, as for instance five hundred or a thousand. It also must be rendered into rods, or as such a fraction of a mile.

Suppose we substitute the metric system for these many clashing ones. Let it be the standard, the common measure of them all. What is a *metre*? We do not mean what it is theoretically, or what it is founded on; that, as we have already said, matters little. There is something appalling in fractions. The writer, who all of his life has had something to do with computing areas and quantities, cannot but confess to have long entertained a vague dread of a metre, because he had seen it stated it contained 3 feet 3⅜ inches *nearly*. It was a little more reassuring to see it stated decimally as 3.2809 feet. Now, while for long calculations we must look up final decimals even further than this, yet we will get a better general idea if we simply call a metre 3.28 feet, or if the reader is familiar with links, he may still better understand it if told that a metre is almost exactly five links—a statement much nearer absolute precision than to say a link is eight inches, or that 15 links is 10 feet. Multiply 3.28 by 5 and we have 16.40 feet, and we see that five metres only lacks 1¼ inches, or 0.1 feet of being a rod. Ten metres = 32.81 feet or 0.19 less than two rods. Twenty metres =65.62 feet, 0.38 feet or 4½ inches less than Gunter's chain. Compare the subdivisions. A Gunter's chain has 100 links; each link, 7.92 inches or 0.66 feet. One decimetre is 0.328 feet, a close approximation for half a link. Ten links = 6.60 feet; two metres 6.56 feet; difference at ten links 0.038, or about half an inch. It will thus be seen that if we take an ordinary Gunter chain, and shorten every tenth link by taking out a ring, or otherwise reducing its length less than half an inch, or 0.38 feet for the whole length, we have a chain adapted to the metric system at a small cost, and sufficiently correct throughout its entire length for any work it was previously fit for. A little reflection will show that a chain of 20 metres would be well adapted to retrace old lines, or re-surveying lots originally measured with Gunter's chain. In measuring half a mile the side of a 160 acre farm, the same number of chain lengths, forty, would only fall short about 15 feet; while for re-surveying in a block of town lots its convenience would be appreciated. The transition from chains and links to metres would be surprisingly easy—much more so than the change now necessary to make in reducing chains and links to feet, inasmuch as the distances given could be approximated without computation. It would not be so easy to reduce feet to metres, still we cannot regard it as involving the labor that is now occasioned by the continual reduction of rods and chains to feet, and *vice versa*.

The new unit of square measure, the *are*, would have a definite and rational relation to the lineal measure, being a square, each side of which is ten metres, and its introduction would render it possible to express small areas, as of lots, intelligibly, an advantage of no small moment, but which has been almost wholly lost sight of, from the habit of expressing distances in feet, and which we are hardly prepared to appreciate.

THE prospectus of a new Atlantic cable company is announced under the name of the Union Atlantic Cable Company.

ON THE USE OF FASCINES IN THE PUBLIC WORKS OF HOLLAND.*

BY THOMAS COLCLOUGH WATSON, M. INST. C. E.

(*Concluded from page 162.*)

In some instances, where the bottom is firm (as on sand), and the bank only much exposed on one side, no grondstuk is used, and only one lateral dam worked up chiefly for convenience of closing, and to prevent the stuff forming the body of the dam being washed away by the current during construction.

These coverings are either temporary or permanent. The former are of four kinds, viz.: "Krammatten," "Bladriet," "Rysbeslag," and "Hangstukken."

A "krammat," used on slopes or berms above low-water level where the wash is not great, is made of wheat or rye straw combed out straight and spread closely over the surface up and down the slope in a layer of about 1 inch to 1½ inch thick. This is kept in place by well-twisted straw bands, "bengels," about 4 inches in circumference, laid at right angles to the straw, and thrust into the ground at intervals of 4 inches to 6 inches, with a blunt fork called a "kram," to about 7 inches in depth. The straw bands are about 2 feet apart. The cost of this protection is rather more than 2*d.* per square yard, and it will last about a year.

"Bladriet" protection is made by covering the ground with reeds (cut when green) to a depth of 4 inches; across the reeds lines of pegs are driven and wattled with "latten" as in the "tuinen" of the "grondstukken"; the lines of tuinen are 2 feet 10 inches apart. This covering is used for slopes likely to be covered by a few extraordinary high floods in the course of a winter. It lasts about a year; the cost is 5*d.* per square yard inclusive of labor and materials.

"Rysbeslag" is used on slopes above low water, and is the strongest of the temporary protections. Reeds are first laid horizontally along the slope or berm 1 inch in thickness, then at right angles a layer of fascines 5 inches thick; across these again stakes are driven and tuinen are interwoven, the rows of tuinen being about 2 feet apart. The whole surface is then covered with heavy stones, about 8½ cwt. per square yard. The cost without stone is 1*cd* per square yard; it will last three or four years.

"Hangstukken" are fascine mattrasses like "zinkstukken," but thinner, sunk on slopes under water and heavily laden with stone. They last for many years, and are used for permanent and temporary protection.

Permanent protections are of three kinds:—"Hangmatten" (just described), brick and stone paving.

Brick paving is only used in sheltered situations; the bricks are set in a bed of sand, sometimes on edge and sometimes on end.

Stone paving is the covering employed on all the exposed slopes of the main dams. A bed of good well-worked clay, usually 3 feet 3 inches thick and watertight, is spread over the slope; this is covered by a layer of broken bricks; then comes the paving of stone 1 foot thick, generally basalt, granite (from Norway), or Belgian limestone. The stones are not dressed; the workman selects those that will fit together without leaving large joints; about 1 cwt. is used per square yard of slope. Should the slope have no horizontal berm at the foot, "peikoen palen" or heavy oak stakes are driven along the toe about 1 foot apart. In very exposed situations groynes of fascines are run out, laden with stone, to protect the pitching from being undermined. The cost of this last species of protection is about 6*s.* 8*d.* per square yard.

Such then are the uses to which fascines are applied in Holland. It remains only to notice the extraordinary skill of the workmen, chiefly natives of Zealand, called "rys-werkers," who make this class of work their peculiar occupation. Twenty men will construct a "zinkstuk" 200 feet long and 60 feet wide in four days; the sinking, if all goes well, occupies about two hours.

The foregoing description has reference generally to internal works, or mere foreshore defenses. Emboldened by the success and durability of hydraulic works constructed with fascines, Dutch engineers have within the last ten or fifteen years, determined to try how jetties, or moles similarly constructed, and carried out 1,100 yards or 1,650 yards from the shore, will resist the action of waves. In 1862 Government resolved to provide Rotterdam with a better channel to the sea; to which end, the peninsula called the "Hoek van Holland" has been cut through. At this spot the coast is of sand to an unknown depth, sloping gradually seaward at the rate of 1 in 150 to 1 in 200, so that a depth of 26 feet below low water is only attained at a distance of from 4,000 to 5,000 feet from low-water mark. Two piers (984 yards apart) are now being made—the northern pier overlaps the southern in order to protect the entrance from the heavy surf raised by the north-west winds. A narrow channel has been dredged to about 10 feet below low water between the moles, but the depth required is to be attained and preserved principally by the scouring action of the river Meuse, which, being partly cut off by the dam across the "Scheur" from its ancient outlet, is driven through the new channel, and so far has carried away more than 6,540,000 cubic yards of sand, the stuff removed by dredging being only about 2,000,000 to 2,600,000 cubic yards. Ships drawing 12 feet to 14 feet of water already use the new cut, which, however, is far from being completed.

* A Paper read before the Institution of Civil Engineers, London.

The moles are formed chiefly of fascines, and so far have been successful. The work was commenced in 1863; the northern pier is completed to a length of 2,078 feet from the shore; the southern pier is quite finished, the length being 1,258 yards, the extremity terminating in a depth of 16 feet 5 inches at low water.* Hitherto the works have suffered comparatively trifling damage from the sea, which is at times very rough. It remains yet to be seen how far the brushwood, of which the fascines are composed, will be affected by the sea-worm and general decay.

The piers are constructed of successive layers of zinkstukken weighted with about 10 cwt. of stone per square yard. The mattrasses are 54.7 yards long by 26.2 yards broad, and 1 foot 8 inches thick without the stone. The entire cost, when deposited in place, stone included, is 11*s.* 3*d.* per square yard, this high price resulting from the risk and difficulty of sinking such large masses in the open sea. The body of the pier takes from five to six mattrasses, averaging, with the stones, about 3 feet 3 inches thick; these are further held in place by five rows of piles driven about 11 feet or 12 feet through the mass into the sand below. The outer slopes and edges of the mattrasses are covered with a coating of stone averaging 13 cubic feet per lineal foot of pier. The part above water is covered with larger stones, retained by rows of small oak piles, the ends of which project above the level of the work, with a view of breaking the force of the waves.

The crown of the southern pier is 26 feet 3 inches wide, rounded on the upper surface, which attains the level of ordinary high water. The piles connecting the mattrasses are carried to a height of 9 feet 10 inches above the top of the piers (*i. e.* ordinary high water), by cross cells. Attached to the piles a timber roadway is constructed, with a line of railway for conveyance of the materials to the ends of the piers in course of construction.

The theory of this system of breakwater is—

First. That being to a certain degree elastic, the shocks from waves produce less injury than on a divided mass (as blocks for instance) perfectly rigid.

Secondly. That in a short time the internal interstices will be completely closed with sand; while the exposed surfaces will be coated, and so to speak agglomerated, with sea shells, weed, etc., so as to form eventually a solid mass, and at the same time protect the interior work from decay and the attacks of worms.

The cost of the south pier was £145,000—about £38 9*s.* per lineal foot—a moderate expense for a pier averaging from 13 feet to 16 feet 6 inches high, where the cost of rubble stone is from 7*s.* 8*d.* to 9*s.* 2*d.* per cubic yd.

The objections to this system are that the progress must necessarily be slow, as the zinkstukken can only be sunk at rare intervals of calm weather. Nor is the problem yet definitely solved as to the durability of the fascines and timber-work.

The works have been carried out under the direction of Mr. M. P. Caland, Engineer-in Chief and Inspector of the "Waterstaat" or Dutch "Genie Civile." The Resident Engineer is Mr. M. J. Kluit.

A more detailed account of this great national work will be found in the report of Major-General Barnard, of the United States' Army, on the "North Sea Canal of Holland; and on the Improvement of Navigation from Rotterdam to the Sea;"† and in the "Notice sur les Travaux Publiques en Hollande, par M. P. Croizette Desnoyers, Ingenieur-en-Chef des Ponts et Chaussees, 1874;"‡ from both of which treatises part of the information contained in this paper has been derived.

The following extracts from the schedule of prices of the specification of the piers of the "Hoek van Holland," show the relative cost of each description of work:—

	£.	*s.*	*d.*
1 cubic metre zink or grondstuk (without stone), sunk in place	0	7	8
1 cubic metre fascines "rysbeslag," placed above low water	0	6	11
1 square metre fascines, with tuinen	0	1	3½
1 metre run of "tuin"	0	0	5½
1 last (2 tons English) Tournay or other stone, sunk	0	11	10½
1 cubic metre oak, rough (35 cubic feet English)	5	14	7
1 " " sawn to measure	8	10	3
1 " " red pine timber	5	19	3
1 " " white pine, or fir	4	5	10
1 lineal metre oak piles, 3 to 6 metres long, 0.60 to 0.80 metre circumference	0	6	11
1 lineal metre oak, 18 to 25 square, 3 to 5 metres long, driven	0	7	8
1 lineal metre oak, 5 to 10 metres long, 0.25 to 0.30 metre square, driven	0	11	2
100 oak stakes 1.2 metre long, driven	2	14	6
1 kilogramme forged iron, in place	0	0	7½
" cast " "	0	0	4½
1 day laborer, fascine worker, or pavior	0	2	1
1 day cart, with two horses and driver	0	7	8

APPENDIX.

ON THE CONSTRUCTION OF THE SEA JETTIES FOR THE IMPROVEMENT OF THE NAVIGATION FROM ROTTERDAM TO THE SEA.

The jetties consist of fascines, ballasted with stone and fixed by piles of oak.

*December 3d, 1874. The Dutch Minister has this day introduced a bill into the Chamber, proposing to lengthen the south pier 492 yards, and asking a credit of 756,000 florins (£63,000), being at the rate of £128 per lineal yard. Sand has accumulated round the ends of the moles, the deep-water line seeming to recede from the shore as the moles advance into the sea. At present the depth is not 6 feet 7 inches at the end of the south mole at low water, where formerly it was 16 feet 5 inches.

† *Vide* "Professional Papers of the Corps of Engineers, U. S. Army," No. 22. 4to. Washington, 1872.

‡ 4to. Paris, 1874.

The top width of the jetty is 29 feet 6 inches. The height of the stone pavement, taken at the centre, is 3 feet 11 inches above low water. The pavement is set in an arc of a circle, the concave side downward, with a chord of 29 feet 6 inches and a versed sine of 1 foot 8 inches. The fascines are laid in slopes of 1 to 1 at the south side, and of 1 to 1¼ at the north side. The second course of mattrasses (reckoned from the base) projects on both sides, thus forming berms each 16 feet 5 inches wide. The first course projects 19 feet 8 inches on both sides. The slopes of the fascine-work at the head of the pier are 1 in 8; the first course of mattrasses projecting 82 feet and the second 49 feet 2 inches from the jetty.

The mattrasses, which compose the body of the jetty, project northward 6 feet 7 inches, and southward 3 feet 3 inches more than is required by the original section, to afford level spaces whereupon to place the stones to protect the pier.

The thickness of a mattrass varies from 1 foot 4 inches to 1 foot 8 inches, and the filling-in at the axis of the work is 4 inches thicker than at the sides, to make up for the greater compression, occasioned by the increased weight acting on the mattrass. Generally the breadth of the mattrasses does not exceed 82 feet, otherwise the transportation, sinking, and ballasting would offer great difficulties. Their length is unlimited, bu as high speed is required in ballasting mattrasses sunk at sea, extreme length would be unadvisable. The largest piece sunk at these jetties was 164 feet long and 91 feet 10 inches broad, being a superficial area of 1,674 square yards. For the dam across the river "Het Scheur," forming part of the works for the improvement of the navigation from Rotterdam to the Sea, several mattrasses of about 2,392 square yards have been sunk.

The courses of mattrasses must overlap in such way that the joints of the under course are covered by the upper course.

The mattrass is made on shore, near the jetty, between high and low water, and when constructed. is floated to its destination, and fastened by anchors and ropes. Then the ballast stones, weighing, on an average, 120 lbs. each, are deposited on it from small vessels surrounding the mattrass, first over the middle, and afterwards over the general surface, till the mattrass is immersed. The sinking lines with which the vessels are attached to the mattrass are thereupon paid out, and at last detached; and in the meantime still more ballast is cast on the mattrass. Generally about 5 cwt. 1 qr. of stone per cubic yard will suffice to bring it aground, but at the north jetty 10 cwt. 2 qrs. of stone are charged per cubic yard of mattrass to oppose greater security against the shock of the waves.

When the fascine-work of the jetty is raised above low water, oak piles are driven through into the bottom in rows reaching 6 feet 7 inches above the water line. Rows of piles are also driven through all the layers under the track of the rails, laid for the conveyance of stone and other material. Elsewhere the rows of piles are shorter, and only serve to secure the stone revetment.

Between the rows of piles around the jetty forming the fore berm, and outside this berm, stones weighing, on an average, nearly 10 cwt. each, are placed. Above low-water level the jetty is formed of osier layers 10 inches thick, secured by hurdles nearly 2 feet apart. The space between these hurdles is filled up to their top with rubbish or waste stone; the entire top of the jetty must be covered with stones weighing, on an average, 1 cwt. each.

In order to get well-connected joints, stones of a more regular form are employed for this pavement. Experience has proved the stability of this mode of construction. heavy storms and strong currents not being able to damage the jetties.

When the bottom, along the head and the sides, is deepened, those parts of the mattrasses protruding from the jetties will, by their flexibility, follow the inequalities of the bottom and shelter the works from undermining.

On a movable bottom the foregoing method of construction offers guarantees of solidity which recommend its adoption wherever want of fascines or stone does not prove an objection.

According to the specifications for the jetties, the following prices are paid:—

	Dutch florins.
For 1 cubic metre of mattrass (without the ballast	4.50
For 1,000 kilogrammes of ballast stone	7.00
For 1 day's wages of a journeyman	1.20

PUDDLING FURNACE ECONOMY.

Not many years have elapsed since it was considered rather good work to make one ton of puddled bars with 23 cwt. of coal, the weight of pig iron charged being not much less in many cases than that of the fuel. It is not unusual in the present day to turn out a ton of bars with 21 cwt. of pig and 14 cwt. of coal, and instances have occurred in which the consumption of coal has been as little as 8 cwt. to the ton of puddled bars. Let it be assumed that a ton of bars can be made with 10 cwt. of coal, and it follows that in ordinary practice more than twice as much coal is used in puddling furnaces as is really required. It is well that our readers should bear in mind that excellent iron has been made with 12 or 15 cwt. of coal per ton, because we have often heard it argued that when serious at-

tempts were made to economize fuel the character of the finished product not unfrequently suffers. If this were really the case, then it is easy to see that sometimes economy could not be practiced at all; while at other times the deterioration in the quality of the finished material might be so great as to run away with all the profit made by reducing the consumption of fuel. We know that puddling furnaces are not as other furnaces. They have to work at different rates, and to perform duties which are practically unique. The operation of puddling depends for its success on the observance of conditions which are in a sense inimical to true economy. Such conditions obtain, for example, once during every heat, when the damper is dropped and the combustion of the gases arising from the fuel is checked as much as possible by the exclusion of air. It is consequently difficult to deal with a puddling furnace on ordinary rules; and the fact has no doubt done much to discourage inventors and prevent them from interfering with a device which requires very delicate handling. It is, consequently, we repeat, of the utmost importance that all concerned should understand clearly that, however delicate the manipulation required, puddling furnaces can be so altered and improved that the consumption of fuel per ton of iron may be brought down to about one-half of that once thought necessary. Nor is this, after all, remarkable. The specific heat of cast iron may be taken as one-ninth that of water. That is to say, a quantity of heat which will raise the temperature of 1 lb. of water 1 deg. will raise 9 lb. of cast iron 1 deg. According to Clement, 233 British units of heat will suffice to melt one lb. of cast iron. The combustion of 1 lb. of coal liberates 14,500 units of heat. Then $\frac{233 \times 2240}{14,500} = 36$ nearly as the number of pounds of coal required to melt one ton of iron. The whole of the heat developed during combustion cannot go to the iron, however. At least 20 lb. of air per lb. of coal must be raised to a temperature of about 2000 deg. and discharged at that temperature up the stack. The specific heat of air being 0.24, then $2000 \times .24 = 480$, the number of units required to raise 1 lb. of air through 2000 deg. Fah., and $20 \times 480 = 9600$ units will be required to heat 20 lb. of air through the same range. But we have seen that the combustion of one lb. of coal only represents 14,500 units, $14500 - 9600 = 4900$ units left available for melting the iron, supplying the losses due to conduction, radiation, etc. Still as one lb. of iron needs but 233 units for its liquefaction, it follows that after the air entering the furnace has been supplied with all the heat it can take up, so much is left that one lb. of coal should suffice to melt over 21 lb. of iron. Now, curious as the statement may appear at first sight, it is nevertheless true that all the useful work really done by the fuel consumed on the grate of a puddling furnace consists in melting the iron. Of course it must be understood that we are speaking now of a furnace thoroughly heated and "going well." Once the iron is melted, and the process of puddling commences, the fuel requisite to complete that process may be supplied by carbon in the metal itself, and that this is not only apparently, but really true, is proved when the puddling process is carried out in a different way—that is to say, in a Bessemer converter. But we know that a charge cannot be puddled in an ordinary furnace if the fire is drawn, and the iron left to supply its own fuel.

We have seen, then, first, that while more than one-half of the whole of the heat set free on the grate of a puddling furnace is expended in heating the air required for combustion, so much is still left that would suffice to melt a weight of iron twenty-seven times as great as that of the coal; and secondly, that once the iron is melted, and the process of purification begins, no fuel other than that in the iron is theoretically necessary to complete the process. How, then, are we to account for the enormous consumption of fuel which actually, and, in a sense, of necessity, takes place during the process of puddling? The answer to this will, we believe, go far to account for certain anomolous results obtained now and then, and not fully explained on any hypothesis which we have seen in print, and it will also indicate the direction which ought to be taken to save fuel.

That the carbon in the iron ought to supply all the heat required is certain; that it does not in practice supply it is very well known. The reason appears to be that while in the Bessemer converter the whole of the carbon contained in a charge of five or six tons is burned away in about a quarter of an hour, the whole of the carbon in a charge of 4 cwt. or 5 cwt. in a puddling furnace is not consumed in less than an hour and a-half or so. The result is that the heat thus developed is much less than that in a Bessemer converter, and it is not sufficient to keep the metal fluid if unassisted. But the more quickly the iron is puddled the more rapid will be the consumption of the carbon and silicon, and the less will be the quantity of coal consumed. There are no exceptions to this rule. In all cases slow puddling means a large consumption of fuel. Of course we know that the rate of combustion in the grate being constant, if we can get our six heats in a given time instead of five, a saving in the combustion of fuel must follow. But, apart from this, there is no good reason to believe that the quicker a charge is puddled the smaller will be the consumption of fuel, because the carbon contained in the iron being rapidly burned raises the temperature in the mass of melted metal to a higher point than would be the case if the process was protracted. Something of the same character is produced when large charges are puddled, and it is well understood that, other things being equal, the larger the charge puddled the less will be the consumption of fuel. In practice, however, the process of hand puddling can never be accelerated so much that the aid of a furnace can be dispensed with, as in the Bessemer converter and it follows that the fuel is called upon to do work besides melting the iron. But this secondary work, as we may call it, is in one sense not useful, and should in all cases be reduced as much as possible. Indeed, in its reduction must be sought economy of fuel. It is impossible to say much here on this point. We are not writing a treatise on puddling furnaces, but calling attention to a few facts which are persistently ignored by some persons and entirely overlooked by others; but we can within reasonable limits indicate the direction which ought to be taken, and which has in certain cases been taken with great success to save fuel.

It will be pretty generally conceded, we think, that from the time the iron is fairly melted and approaches the boiling period until it is finally taken out of the hearth, very little heat indeed is transferred to it from the coal. The duty of the coal during all the principal stages of the process consists, then, in keeping up the temperature of the substances surrounding or in contact with the metal. We have seen that an immense proportion goes to heat the air requisite for combustion, and of the remainder a great deal is disposed of by radiation, convection, etc. It is clear, therefore, that in two ways economy ought to be attainable. One way consists in using the waste heat from the puddling hearth to raise the temperature of the air supplied to the grate; the other consists in reducing the radiating surfaces both in dimension and efficiency as radiators. In a word, the furnace should be as well protected by non-conducting materials as possible, and it ought to offer the smallest allowable surface in proportion to the weight of the charges dealt with. The first plan has been tried—notably at Messrs. Fox, Head & Co.'s rolling mills, Middlesbrough, England—with marked success; but comparatively little has been done as yet in the latter direction. In this connection it is proper to point out that the dimensions and form of the furnace exercise a dominant influence over the consumption of fuel. Thus, for example, if the furnace roof be burned away, so that the distance between the bricks and the bath of metal is abnormally great the consumption of fuel per ton of bars will increase at once. The nearer the furnace crown can be kept to the melted metal the less will be the weight of coal burned per ton of bars, and the reason is obvious. There is a continual escape of heat downwards and around the sides of the hearth from the melted metal to the "bottom" of the hearth. This can only be made up by the heat radiated downward by the incandescent gas and the glowing roof above. The further these are from the metal the less will be their efficiency. There is besides a peculiar phenomenon connected with heat and flame, and not yet so fully explained as is desirable. We allude to the dissipation of heat, under conditions apparently most favorable to its conservation. Thus, the temperature at the end of a long flue would be just as high as the beginning, if all waste of heat were prevented; but we know that in practice no such thing could occur. The probability is that the heat thus lost is really converted into work done on the molecules of the gas. Be this as it may, it is certain that the nearer the gate can be gotten to the hearth of a puddling furnace, the less will be the consumption of fuel. For example, careful experiments conducted at Woolwich, England, showed that considerably over 50 per cent. could be saved in fuel, simply by making the grates short and wide, instead of square.

In conclusion we may say that our object in writing this article has been to direct attention to the influence of form and arrangement of furnace on the economy of fuel in puddling. We have here a great field only partially worked. So long as mill managers believe that the burning of coal is essentially necessary to the performance of the operation of puddling no great economy will be sought for. If, however, they will but recollect the truth that once the metal is melted, coal is burned only to compensate for loss of heat expended in a way that can give no pecuniary return, it is possible that they may begin to believe that the loss is not inevitable. At one end of the puddling system we have a consumption of as much as 50 cwt. of coal burned to make a ton of bars; at the other we have the Bessemer converter, which cleans a ton of iron of all carbon and silicon without any coal whatever. Between the two there is a wide range of fuel consumption. But let it be once believed that the only fuel chemically required to puddle a charge of pig iron is that needed to melt the iron, which contains all the fuel necessary for the completion of the process, and a great step will be gained. The direction which improvement must take is very plain. Efforts should be made to prevent loss of heat by radiation, etc., from the furnace; to raise the temperature of the air supplied to the grate with the waste heat; and so design and proportion the furnace that the fuel and the iron may be brought as close together as permissible. All the results obtained from experiments in this direction are eminently encouraging; but much remains yet to be done. It will be seen that we have not referred to any particular type of furnace, and it will be understood that all we have said relates to the process of hand puddling. If any of our readers are in a position to place on record in our pages the results of experiments on the form and dimensions of puddling furnaces, they will, we can assure them, do good service to British iron makers. —*From the Engineer.*

CORRESPONDENCE.

RICHMOND, VA., *June 21st, 1877.*

Editor ENGINEERING NEWS:

SIR,—"Another Subscriber" has not answered my query. I want to know the most judicious proportions for the opening of the culvert—railway culvert, not sewer. If the span $= s$ and the height of abutment $= h$ what should be about the value of $\frac{s}{h}$. This value usually is 2, I believe. Is that nearly correct?

SUBSCRIBER.

NOTES.

English geologists have watched with great interest the progress of a well which has been bored for the benefit of a London brewery, and which has just been successfully finished. At 150 feet the clays and gravels were passed, and the upper chalk began; from 490 to 812 the work lay through hard lower chalk and marl; at 840 feet, gault; at 1,004 feet the soiled green-sand was reached below which water is already found. The work was done with a diamond drill. One crown of diamonds has cut 400 feet; but the strata have proved of very varied hardness, and the flints in the chalk have occasionally delayed the speed of the work. When there were no mishaps the progress was fourteen or fifteen feet a day. The value of the diamond crown of the boring tool is about $500.

Mr. H. D. Haddock, clerk of the propeller Peerless, reports that when passing through the Sault Canal, Straits of Mackinac at noon on the 18th inst., the water suddenly ran out leaving the Peerless upon the bottom for about ten minutes, when it as suddenly raised to the usual level and floated her off. During the forenoon there was considerable excitement at Saulte Ste. Marie, caused by a tidal wave, which swept the water into Lake Superior (the water falling about four feet), leaving vessels in the canal aground, and affording a dry pathway across the rapids to the opposite shore, an opportunity of which many availed themselves to walk where man had never walked before, at least not within the recollection of the "oldest inhabitant." In about two hours the troubled waters of Lake Superior became still and flowed back into the canal and rapids.

Major Powell, U. S. A., in charge of the Geological and Geographical Survey of the Territories, has already sent out five parties, all of which are at work in Utah Territory. The triangulation party, under Professor Thompson, is located on the eastern slope of Wahsatch mountains. Three geographical parties, under Messrs. Renshaw, Wheeler and Grover are pretty busy prosecuting their work on the Uintah, Price and Lower Green rivers, and a geographical party, under Captain Dutton, of the Ordnance Department, U. S. A., is located on the central plateaus. Major Powell will leave here about the first of July for the field, and in the meantime two other parties will be fitted out for work this season, one of which will make a specialty of the subject of irrigation in Utah. It is expected that the geographical work in Eastern Utah, which has been prosecuted with vigor for some years past, will be finished this season.

The proprietors of the speaking telephone are putting instruments into use in Providence, R. I., to a limited extent, selecting a few specimen cases to insure the instrument a full test for practical purposes. During the past few days a small hand telephone, recently perfected, has been put on the line from the Mayor's office to the office of Chief of Police, and on the line from the office of the Lippitt Manufacturing Company to the Silver Spring bleachery. On both lines the instruments are giving full satisfaction and exciting a great deal of attention, that on the Lippitt line especially attracting the attention of manufacturers and business men, several of whom have expressed a determination to introduce the instruments in their business at the earliest possible moment. The small telephones are not over five inches in length and weigh less than half a pound, but do all the work for practical purposes of the larger instruments shown in the halls.

About a quarter of a mile from the depot at Schodack, on the Boston and Albany Railroad through the farm of Peter Timeson runs a creek which supplies the paper mills of Horton Harbor and Van Benthuysen & Sons, of Albany. A short distance from the creek on the farm there was until Tuesday an immense hill, or mound of earth. Early on the morning of the 12th inst. this hill began sliding and filling up the bed of the creek, and has completely dammed it, turning the course of the stream over another farm—a large lake has been formed where before were thrifty fields of corn and meadow. Hundreds of persons have visited the spot, and careful engineers say that fully a million tons of earth has been displaced. A spring was directly underneath the centre of the hill, and a stream of pure cool water now runs from it, having already made a channel for itself through the *debris*.

The cause of this singular change in the topography of the locality is attributed to the undermining of the hill by the spring.

Wet and dry rots are two forms of decay which attack timber that is exposed to the action of the weather, and the cause of both may be said to be heat with moisture. Confined air and evaporation cause dry rot, and imperfect evaporation wet rot to a greater or less degree. Investigation shows that as a preventive against these rots the timber should be well seasoned, and if used where liable to be under the influence of sun and rain should be well painted, or, if not painted, should be impregnated with linseed or oil of tar. The best preventive, however, is found to be that of allowing a free circulation of air around the timbers, and the walls to be allowed to dry thoroughly before the introduction of the timbers; should the timbers have taken either of these rots very little can be done to preserve them. In case the rot is perceived to be at the ends of the beams only—where in fact it generally commences—the best method of preserving the rest of the timbers is to effectually cut away the decayed portion and scarf with sound; if, however, this should not be practicable, the wood may be scraped and cleaned of all fungus or extraneous matter and then impregnated with any of the usual oils.

A patent has just been granted Loring Pickering, one of the editors and proprietors of the *Evening Bulletin* and *Morning Call*, of San Francisco, for a method of rapid telegraphing of *fac similes* of stereotype plates. It is claimed that by the process an entire page of a newspaper can be transmitted by telegraph in from fifteen to thirty minutes, delivering the copy directly from the instrument in such a form that it can be handed immediately to the printers. In other words, the copy will be a substantial reproduction of the original, except that it may be given in larger sized letters if so desired. The stereotype requires no preparation for the purpose of telegraphic transmission other than the filling of all its depressions or spaces between the faces of the letter with a non-conducting substance which may be quickly applied, the face of the type being left clear. By means of an equally simple process the plate thus prepared is placed upon a cylinder arranged to revolve rapidly so as to present each successive letter to fingers attached to a traveling frame. As the cylinder bearing the plate revolves the frame gradually advances by the operation of a screw, and thus each and every line is successfully presented to the fingers or magnetic points mentioned. Necessarily the circuit is open when the points are passing over the non-conducting surface but as often as the metal type presents itself to said fingers the circuit is closed and corresponding magnetic points or pens at the receiving station make the record their in the same letter as the original, delineated in a series of fine lines either upon chemically prepared or ordinary paper fixed upon a corresponding cylinder at said receiving station.

RAILROAD NOTES.

An ingenious invention for economizing fuel, successful in London, is about to be tried on the Grand Trunk road. It consists in making the sides and bottom of the furnaces of engines of tubular plates, through which the hot water flows from and into the boiler. The saving of heating power is plain, and in practice it is found to be about thirty per cent. of the fuel consumed.

Recently, during one day, Whit Monday, 246,547 passengers were carried on the Metropolitan Underground Railway, London, being at the rate of ninety million passengers per annum. The stations are half a mile apart. The trains run every two minutes; they consist of twelve cars each, and are drawn by *locomotives weighing forty-five tons* each. They discharge and take up a load of passengers, run to the next station and stop, all within the space of two minutes.

In the suit of Daniel E. Sickles and others against the Chicago, Saginaw & Canada R. R. Co., Benjamin Richardson, and others, to declare void $3,574,000 of the bonds of the road, bought in by Mr. Richardson at five cents on the dollar on a sale by the Sheriff to satisfy a judgment of Richardson's; judgment was entered yesterday for the plaintiffs. The plaintiffs took a default Friday, June the 8th, before Judge Donohue, but Judge Gilbert granted an order to show cause why this default be not opened, with a stay of proceedings meantime. On a statement of what had occurred before Judge Donohue, Judge Gilbert vacated his order *ex parte*, and on June the 12th, Judge Donohue signed the judgment, appointing Henry A. Smalley receiver of the bonds to carry out the judgment. Elihu Root appeared for the plaintiffs; Dexter A. Hawkins for the defendants.

The crooked nature of the railway from Galatz westward, parallel with the Danube, is a peculiarity which there is nothing in the surface of the land to account for. A correspondent of *Le Temps* explains that in following out on the map the capricious zigzags which the principal Roumanian R. R. describes, a circumstance which becomes more complicated in the eyes of the traveler by reason of a number of curves of a utility more than questionable, one asks himself the reason of this extraordinary antipathy for straight lines, which has placed under the cannon of the Turks an important point in the line of communication so valuable, since it would have been more direct and safer to have one line run ten good leagues distance in the interior. Here is the singular explanation they give, such as it is. The Roumanian R. R. was undertaken by Strousberg. It was a memorable impudence, to speak with prudence. One of the stipulations of the contract was that there should be a certain subvention per mile, and this was accorded before the line was laid out. The contractor accordingly lengthened his line with curves to the utmost possible extent.

The *Railway Review* says:—On the 4th of June, the steam car "Baldwin" completed the 76th day of continuous service, having run 88 miles every day, Sundays included, since March 21st. It has cost nothing for repairs, and has never failed on any grade nor left the track on a curve. We are pleased to lay before our readers an official opinion of this car and the use of steam on street railways in general.

Office of the MAYOR OF PHILADELPHIA, May 26th, 1877.
Messrs. Burnham, Parry, Williams & Co.

GENTLEMEN:—Your communication of today was received. It affords me pleasure to express my favorable opinion of the use of steam upon our city passenger railways. I have carefully examined the workings of the Baldwin steam car now in use upon the Market street line, and my opinion is that it is superior to any ever tried in this city; and in the performance of work of ascending grades, is admirable, and a great success. The only objection to the use of steam upon our highways ever made was the fear of our citizens lest frequent accidents should occur by reason thereof, but the recent experiment has proven that they can be run with as much safety as any other. I have heard of no complaints since your steam cars began service on the Market street line, but on the contrary, have heard them commended in the strongest terms.

I am, gentlemen, yours respectfully,
WM. S. STOKELY, Mayor.

The *American Manufacturer* says: Some weeks since we noticed the fact that the National Tube Works Company was about to build fifty freight cars by the La Mothe patent, which was described in our columns. Six of these cars are now in use on the Pittsburgh branch of the Baltimore & Ohio R. R., while twelve more are ready for use, and the balance in shops to be completed very soon. From what can be seen as they now stand upon the track the company have not claimed too much for their strength, and every load that the trucks or rails will bear would be light as compared with the great strength that must be secured in this ingenious and practical combination of wrought iron tubes and rods, while the elasticity of the car, so essential to safety in transportation and economy in rolling stock, seems perfectly secured. It is reported that some in use have carried a load of twenty tons, and, so far as the car is concerned, it looks practicable, but it may be found better adapted to the present system of tracks and bridges in the country to make a car of less weight and cost to carry the usual load of ten tons, a very feasible plan which would work great economy in strength as well as weight over the common car. The box cars have a frame made of Bessemer steel rods, covered with sheet iron, firmly secured in iron joints, very ingeniously made, and lined with wood. The company is now ready to have these cars put to the severest tests, and from the numerous inquiries received some of these tests will be very interesting, and if iron and steel do not come off victorious over wood it will be very strange.

PORTLAND CEMENT.

MR. G. F. Deacon, Borough Surveyor of Liverpool, has published a Paper on Portland cement, which he read some time back before the Liverpool Polytechnic Society. As it contains records of trustworthy experiments, it will be found to form a valuable supplement to the well-known Papers on the same subject by Mr. Grant, of the Metropolitan Board of Works. Mr. Deacon was not satisfied with the kind of block which was devised by Mr. Grant as the best in form for testing the tensile strength of cement, and which has since then been commonly adopted in experiments—that is, a block with square sides, except in the central part, to which the test was supposed to be applied, and where for about one-fifth of the length of the block the form suddenly became concave. It seemed to him that "unless the cement throughout the fractured section were perfectly homogeneous, it was highly probable that one or both of the parts immediately adjoining the shoulders where fracture commenced would have a density differing more or less from the mean density." Accordingly Mr. Deacon had made a test block, which was also of less section in the middle than at the ends, but was without corners or sharp curves in any part. More than five hundred experiments were tried with the same cement formed in both kinds of blocks, and it was found that while a block of the London pattern would indicate a breaking weight of 647 lbs. for a section of 2¼ square inches, and seven days after gauging, the Liverpool block would give a strength of 753 lbs., or an additional strength of nearly 16 per cent. From this it becomes plain that it is not sufficient in specifications to prescribe a certain degree of strength as requisite for Portland cement unless the form of the test block is likewise stipulated. The standard specified by the Metropolitan Board of Works is 787 lbs. on the sectional area of 2¼ inches, or 350 lbs. to the square inch; but with his new block of the same area Mr. Deacon specifies the tensile strength at not less than 800 lbs. per block area, and the average strength of the cement supplied during a year amounted to 871 lbs. For ascertaining the transverse strength of Portland cement, Mr. Deacon suggests the following specification:—"Samples of pure cement shall be gauged with water, and pressed into a mould 10 inches by 1½ inch by 1½ inch. The block of cement thus formed shall be placed in water, and, after seven days, tested by placing it on supports 9½ inches apart, and gradually applying a load of 150 lbs. on its centre. If more than one out of three blocks are broken within one minute of the application of the load, the engineer or architect shall be empowered to reject the whole of the cement from which the supplies were taken."

The following is the specification for Portland cement which is adopted in Mr. Deacon's office:—The cement must be of uniform quality and capable of bearing the following tests to the satisfaction of the engineer:—1. Samples of the cement, being sifted through a No. 50 gauge wire sieve, must not leave a residue of more than 10 per cent. 2. Samples of pure cement will be gauged with water and placed in the brass moulds used by the Corporation. Within twenty-four hours the casks thus made will be immersed in still water, in which they will remain until the expiration of seven days from the date of moulding, when they will be taken out of water and tested to ascertain their tensile strength, which must not be less than 800 lbs. on the sectional area of 2¼ square inches. 3. In ordering the cement it will be distinguished as quick setting or slow setting. The slow setting cement, when gauged neat in the moulds, must not become firm in less than three hours. The quick setting cement must assume a firm condition within half an hour. The test for firmness will be that of resistance to the finger nail, the test at present adopted in the department.

The above tests will be applied after each delivery, and should the result be unsatisfactory to the engineer, he may—having given notice to that effect to the contractor within eleven days of delivery—require the whole of such cement to be removed at the contractor's expense. With each delivery the contractor shall send a memorandum of the quality delivered and the name of the manufacturer.—*The Architect, England.*

CONTRACTORS' INTELLIGENCE

F. W. Merz & Co. of Louisville, Ky., architectural founders are getting patterns ready for casting four Corinthian columns each 3 feet in diameter, and 28 feet long; the largest columns indeed ever cast in the world. These columns are to support the entablature of the main portico in front of the State Blind Asylum.

The Oscoda Salt and Lumber Company have taken a contract to furnish the Chicago & Northwestern R. R. with 200 bridge chords. The railroad company have been searching for this timber at the different ports on Lake Michigan, without success, finally finding it in Oscoda. The chords or stringers will average 70 feet in length, and are to be manufactured out of as fine logs as the forests of Michigan afford. The company have just finished an order for an ice company in Chicago for a number of pieces each 16 inches square and 44 feet long, the same to constitute the posts of an enormous ice-house.

The citizens of Brockton, Mass., at a town meeting, held on the 14th inst., adopted the plan proposed in the report of Percy M. Blake, C. E., of Taunton, Mass., for the admission of water by the stand pipe system, and appropriated $30,000 to commence the work of laying pipe. The entire cost of the dam and conduit, pumping station and basin, standpipe and mains, is estimated at $134,068. Water is to be taken from Stoughton pond, which gives fifty feet fall at Brockton, and is considered sufficient for all practical purposes. The preliminary work has already commenced under the supervision of Mr. Blake.

The Detroit Bridge and Iron Works has the following work in hand: One span of 175 feet and another of 90 feet for the Wabash Railway. These are both Pratt trusses, the larger one having double intersections of the diagonals with the posts, and the other single. The top chords are made of channel bars with covering plates on top and below. Instead of being united together on the under side by lattice work or other method, the channel bars are fastened together by cast-iron diaphragms between the channel bars and filling up the entire space between them. This arrangement, it is claimed, not only ties the two bars together, but gives them what we will call diagonal stiffness. The longer span bridge is to be erected near Rockfield Ill., and the other near Jacksonville, Ill. Other orders are for a combination span of ninety feet for the Chicago, Burlington and Quincy Railroad; about 700 feet of plate girders for the Detroit and Milwaukee Railroad, to be made in spans of 100 feet: a double-track drawbridge for the Union Stock Yards Company of Chicago, 150 feet long; and a fixed double-track through span of 115 feet for the same company. Both of the latter are to be built with three trusses. Besides these, they have an order for a single-track bridge of 120 feet span for the Detroit, Lansing and Northern Railroad.

This company has also built and is running a forge for the manufacture of car and locomotive axles, shafting for engines, mines and steamers, and is doing a considerable business in that line.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 164.*)

To make use of all these data in calculating the probable cost of a piece of road, there is of course still wanting the equally essential factor which gives the number of cubic yards to be dug and moved and the distance of transport. These are got from the plan, profile and cross-sections of the proposed work, an engineer's knowledge being requisite to make the necessary drawings and calculations.

DRAINS AND CULVERTS.

The drainage of roads is of two kinds; surface and sub-drainage. The first provides for a speedy removal of the rain-fall on the surface of the road and the cutting and embankments on which it is carried; the second, for the removal of that part of the rain-fall which nevertheless does penetrate into the body of the road-covering. With a perfect sub-drainage the winter's frost, having no water to act upon within the body of the road, is robbed of its great power to destroy the same, and it also prevents the road-surface from becoming soaked and thence destroyed in the summer. The need of surface drainage is self-evident. This last named is to be provided for at this stage of the building of the road, the sub-drainage being more properly a part of the building of the road-covering or top. For this purpose ditches, one on each side generally, are absolutely necessary, both when the road is on a level with the surrounding country and when it is in a cutting. They may become necessary also in the case of embankments: for example, when an embankment is built across low ground. Where these side ditches cross under the embankment we have a culvert: also whenever any small valley, having a constant or intermittent stream of water, is crossed by such an embankment. It is very bad policy to make such culverts of wood, unless indeed they are so situated as to be constantly under water; the cost of replacing them after the embankment and road has been built over them is disproportionately great. They should be made of stone, or brick; lately vitrified stone-ware, or cement drain-pipe, oval or egg-shaped, has been used to advantage in their construction.

All ditches, drains and culverts should have a fall throughout their entire length. Their size will depend on the amount of water they may be expected to carry, and this again on the rain-fall that may occur on the area which they drain. Extraordinary showers have occurred of 2 inches in half an hour but only over a very limited area, and 2 inches in an hour may be taken as a large allowance. This is the basis of the Central Park drainage calculations, and is larger than usually taken, none too large however for safety.

The determination of the proper width and height of culverts, that will enable them to pass the requisite quantity of water without damming it up, is a question in practical hydraulics, easily enough settled, in cases of doubt, by the proper gaugings and observations made upon the spot, but which is answered only in a very crude and imperfect manner by any general rules that may be given. And yet it may prove a very important question at times. There is now (1877) pending in Massachusetts, a suit for damages, that may involve claims to the amount of about half a million dollars, in which one great centre of attraction is nothing but a simple railroad culvert, and the question: Was it as large as it ought to have been? and the writer passes every day, when at home, by a culvert, which for some 150 or 200 years has dammed waters of a brook back about 3 miles, from 1 ft. to say 20 inches at the culvert vertically, and done this right along two or three times per annum, and at the present time it contributes in this manner, more than its proper share towards the flooding of about 500 cellars. These two cases may serve to call attention to the great damage that may accrue from making culverts too small, and show whence comes the rule: in cases of doubt, make the culvert plenty large enough. The following rough and approximate rules for determining the quantity of water that a culvert will be called upon to pass through it, are taken from a German pocket-book for road engineers. Compute the cubic feet per second from the drainage area that lies above the culvert, and, for the different lengths of valley from the corresponding rain-falls per hour, (the rain-fall is given in inches per hour, instead of in decimals of a foot per second, only for the purpose of avoiding the printing of long decimals.)

LENGTH OF VALLEY IN MILES.	INCHES PER HOUR.
2.5 or less,	1.2
2.5 to 5.	0.75
5. " 7.5	0.45
7.5 "10.	0.30
10. or more,	0.15

As culverts grow larger and wider with the amount of water they are to pass under the road, they develope finally into

BRIDGES.

Bridge-building is a life's study, taken by itself, and in some of its parts it is not half appreciated and known as yet among the public. Prominent among these is beauty of design and *appropriateness to the situation.* There is perhaps nothing else that will so much improve the appearance and attractiveness of a road as a beautiful bridge. So also in cities we find that a street will of its own accord seemingly improve in appearance, when a good and handsome bridge has been erected on its line, the owners and builders of the adjoining buildings taking the bridge for their pattern and model. Nor must it be supposed that a handsome bridge must necessarily cost more than an inappropriate or homely, uncouth structure; it need never be the case. Very often the chief beauty of a structure lies in the fact of its carrying the most with the least expenditure of material. No one bridge is proper in every situation, and herein are many mistakes made. The correct way to build a good bridge, is the same or a similar way to that followed in first-class buildings, namely, to have plans drawn for the same and receive estimates and offers to build according to these plans. It is not well to allow the offices of designer, superintendent and contractor to be united in one person or firm, and is expecting too much from human nature.

MAKING THE ROAD SURFACE.

There are two subordinate kinds of road surface, if the term road can properly be applied to them, namely, that of foot and riding paths; these may be disposed of first, before proceeding to the more important consideration of the road surfaces proper, those used by vehicles of all descriptions.

Footpaths.—For the surface of a foot path little solidity is necessary, except in city sidewalks, which are not supposed to be treated of here, but we do need a material that shall become and stay compact soon after it is laid. Coarse sand, screened gravel, stone chips and dust, make good paths; should these materials be too free from any earth or clay, a little of the same may often be added to advantage to act as a binding material. Wherever the ground underneath the surfacing is not porous or likely to remain porous enough to let all the water that may soak through drain away, a layer of such porous material must be filled up before the top surface is put on. Oyster shells, or large stone chips, gravel stones or pebbles, etc., make a good foundation of this sort. The top covering should have a slope, best in both directions from the centre of the path towards each side of about 1 in 16; the thickness of the foundation course to be 3-5, and that of the top 3-4 inches.

No gravel path, or side-walk, will afford good walking at the season of the year when the frost is coming out of the ground. Carting on more gravel is in vain; it often is no better than mere foolishness. If village communities will get this idea firmly into their minds, and, instead of a fruitless struggle against the laws of nature and of gravel, will build stone screening sidewalks *with a good foundation course* underneath, as above described, or else some sort of hard sidewalk covering, they will save themselves much expense, many muddy feet, and no small amount of consequent and annual discontent, not to say profanity and ill feeling.

Heavy rolling will save much time in finishing the whole process; the roller should be used unsparingly and throughout the whole construction of the path, on the foundation, as well as on the top.

Riding-Paths.—From the nature of the travel these are intended to acommodate, their surface is of a peculiar nature. Inasmuch as a horse, in galloping, tends to throw the soil he treads on backwards with his feet, the surface must be kept somewhat loose and soft to make riding on it easy and agreeable,

(*To be continued.*)

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

ARCHES;

CONSIDERED GRAPHICALLY.

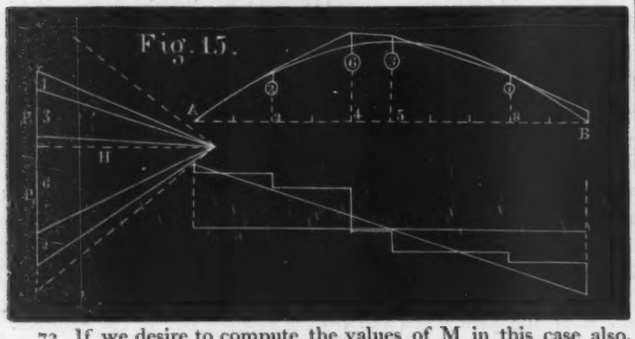
(*Continued from page 160.*)

VALUES OF H, P_1 AND P_2.

n =	0	.2	.4	.6	.8	
$y_0 - y_1$ =	1.0667	0.9778	0.9143	0.8667	0.8296	k
$\frac{y_0 - y_1}{(1+n)c}$ =	1.0667	0.8148	0.6531	0.5417	0.4609	$\frac{k}{c}$
$y_0 - y_2$ =	1.0667	1.2	1.4222	1.8667	3.2	k
$\frac{y_0 - y_2}{(1-n)c}$ =	1.0667	1.5	2.3704	4.6667	16.0	$\frac{k}{c}$
	2.1333	2.3148	3.0234	5.2083	16.4609	$\frac{k}{c}$
H =	0.4687	0.4320	0.3308	0.1920	0.0607	$\frac{c}{k}$ W
$H\frac{y_0 - y_1}{(1+n)c}$ =	0.5	0.352	0.216	0.104	0.028	W } = P.
$H\frac{y_0 - y_2}{(1-n)c}$ =	0.5	0.648	0.784	0.896	0.972	W }

The amount of H for a load at each point will then be as given in the several columns of the above table. The first three values will be seen to be greater, and the last two to be smaller than the corresponding H's in § 46. It will next be necessary to to find P_1 and P_2, or the vertical components of the reactions, by multiplying H by the quantities in the 3d and 5th lines of this table; the results will be found in the last two lines. The largest value of P occurs at the nearer abutment. It will be noted that these quantities differ in amount from the two supporting forces of a single span, beam or truss.

71. If the H's for an equal load at each of the nine points of divisions are added together, we find that, for loads at all points, $H = 2.4997 \frac{c}{k} W$, which may be comprred with the value deducted for a rib with hinged ends, § 47. That it agrees more closely with the amount for a truss or bowstring girder is due to the fact that the curve of equilibrium of a single weight crosses the rib oftener in this case than in that of a rib with hinged ends, so that, when several loads are combined, it will deviate from the parabola (the form of the rib, and the true curve of equilibrium for a uniform distributed load,) very little.



72. If we desire to compute the values of M in this case also, we may use the former equation (13).

$$M = H(y - z).$$

The values of the ordinates to the parabola, z, will be the same as before. If x benotes the distance from A to the foot of the ordinate y, and x' = the distance from B to the foot of the same ordinate, in which case $x' = 2c - x$, we shall have

$$y = y_1 + \frac{y_0 - y_1}{c+b} x, \text{ on the left of the weight, and}$$

$y = y_2 + \frac{y_0 - y_2}{c-b} x'$, on the right of the weight, the sign of y_2 being contained in the symbol. These fractional co-efficients of x and x' have already been computed in § 70. Let us proceed to find the values of M, at both abutments and the nine other points, for a weight on the third point of division from the middle, towards the right.

$H = 0.192 \frac{c}{k} W$; $\frac{y_0 - y_1}{c+b} = 0.5417 \frac{k}{c}$; $\frac{y_0 - y_2}{c-b} = 4.6667 \frac{k}{c}$;

$z = .36\,k, .64\,k, .84\,k, .96\,k, k, .96\,k$, etc., § 49.

VALUES OF M.

W		0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	0 c	$= x' \frac{k}{c}$
n =		0.2 c	0.4	0.6	0.8	1.0	1.2	1.4	1.6	0 c	$\times 4.6667 + y_2$
$\times 5417 \frac{k}{c} + y_1$ =		.1083	.2166	.3250	.4334	.5417	.6500	.7584	.8667	.2667	.36
z =		.4416	.5500	.6583	.7667	.8750	.9833	1.0917	1.2000	.64	.84
$y - z$ =	+.3333	+0.816	−.0900	−.1817	−.1933	−.1250	+.0233	+.2517	+.5600	−.0933	−.6667
										k	c W
M =	+.0640	+.0157	−.0173	−.0349	−.0371	−.0240	+.0045	+.0483	+.1075	−.0179	−.1280

Multiply by $H = 0.192 \frac{c}{k}$ W.

W is placed over the number of the point to which it is attached, and a double line is drawn on one side of W to denote the end of each series, running from the two ends of the table. The dividing line might just as well have been drawn on the left of W, if preferred. More frequent values of any of the preceding quantities may be obtained by interpollation, as explained.

73. A table of values of M has been prepared for this case of an arch with fixed ends, the span being divided into twenty equal parts, and is here presented. M at any one point, for a uniform load at all of the points of division, reduces nearly to zero, as before. The greatest possible positive M, as well as the greatest possible negative M, for any combination of weights occurs at each abutment; positive maximum when the span is loaded from the other abutment to and beyond the centre one or two points; negative when the other portion only of the span is covered. The load on the second point from the middle produces no M at the nearer abutment. There is another maximum at the 6th. or 14th. joint, with loads nearly the reverse of the ones mentioned above. An inspection of the table will show these points.*

74. As soon as H, P, y_1 and y_2 have been obtained for all points, it is easy to draw a curve of equilibrium for any desired arrangement of load. Let us suppose that one must be constructed for weights of 2 tons, 6 tons, 3 tons and 1 ton, on the 2nd., 4th., 5th. and 8th. points respectively, from the left abutment, of an arch of 100 ft. span and 20. ft. rise, divided into ten equal parts along the span, as previously deseribed. We will proceed as follows :—

The vertical components of the reactions cannot be computed for the load in the gross, as for a beam on two supports, but must be summed up from the values lately given. Referring to those data we get

	P_1.	H.
2d. joint,	$0.896 \times 2 = 1.792$ tons	$0.192 \times 2 = 0.384 \frac{c}{k}$ tons.
4th. "	$0.648 \times 6 = 3.888$ "	$0.432 \times 6 = 2.592$ "
5th. "	$0.5 \times 3 = 1.5$ "	$0.469 \times 3 = 1.407$ "
8th. "	$0.104 \times 1 = 0.104$ "	$0.192 \times 1 = 0.192$ "
	$P_1 =$ 7.284 "	$H =$ 4.575 "

* The table referred to will be presented to our readers in our next issue.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

I.

The candidate for the office of County Surveyor in our Public Land States does not usually consider his mathematical attainments of much account in his canvass for the coveted place; his political knowledge and party standing is worth more to him than trigonometry, and how to "pull wires" is of more value than how to "drag a chain". In the steady-going, law-abiding Dominion of Canada it is very different, and the possession of the document which entitles a man to make a legal survey there, is only to be won after three years of hardship, coupled with considerable expense, and more or less of study. It is my intention in the following papers to give my own experience as a surveyor's apprentice for the benefit of that portion of the fraternity of American surveyors who want "more legislation."

Cap. LXXVII of the Consolidated Statutes of Canada is "An Act Respecting Land Surveyors and the Survey of Lands," and contains all the information concerning the method of proceeding to become a surveyor and how to make legal surveys after a diploma is obtained. Section 1. constitutes the Board of Examiners "to consist of the Commissioner of Crown Lands, and eight other compe ent persons to be appointed from time to time by the Governor, and to meet at the city of Toronto, at the office of the Commissioner aforesaid, on the first Monday in each of the months of January, April, July and October, for the examination of candidates for admission to practice as land surveyors in Upper Canada," (the present province of Ontario.) Three members form a quorum, and a secretary is appointed to keep the record of the meetings. Five dollars per diem of actual attendance is allowed to each member of the Board, and if the pay *is* small, the time, like "linked sweetness," may be "long drawn out," especially in the slack seasons of the year, to suit the convenience of the honorable board.

The present board for Ontario is—The Hon., the Commissioner of Crown Lands, ex-officio; Thos. Devine, Deputy Surveyor General, Toronto, Chairman; Members:—J. S. Dennis, Ottawa, Surveyor General of Dominion Lands; F. F. Passmore, Toronto; T. F. Gibbs, Adolphustown; A. C. Webb, Brighton; Hugh Wilson, Mount Forest; P. S. Gibson, Willowdale; Prof. Chapman, University of Toronto, (Examiner in Geology); Geo. B. Kirkpatrick, Secretary, Toronto.

Before this Board all candidates for the office of surveyor *must* come at least twice; the "preliminary" examination is largely a matter of form and occupies but little time; when the candidate comes up for his "final" he may have a different story to tell before he is dubbed a full fledged P. L. S.

The good old days of seven years' apprenticeship to trades, we regret to say, are among the things of the past, and even in the few cases where the odious, ignorant and tyrannical trades unionism of the present allows a boy to have a chance to become a valuable member of society, instead of forcing him to grow up in idleness and vice, to prey upon his fellows, the tendency is towards superficiality, and before a master is compensated for the time spent and material spoiled in making his apprentice of use to him, this latter individual has learned his own importance and demands the pay of a competent mechanic. But for the Canadian surveyor's apprentice there is no chance to air his importance except in the one line of obedience. He dare not act as a surveyor unless duly authorized to practice according to the provisions of the Act, and the only way to the legal possession of the P. L. S. attachment to his autograph is the long, tedious and expensive apprenticeship, except under another condition of which mention will be made hereafter.

The intending apprentice must give one month's notice to the Secretary of the Board of his intention to present himself for examination, accompanying his notice with a fee of one dollar. At the proper time he presents himself at the rooms in Toronto, pays into the Fee Fund ten dollars as the fee due by him for examination, and then is examined as to his proficiency in vulgar and decimal fractions, the extraction of the square and cube root, of geometry, plane trigonometry, mensuration of superficies and the use of logarithms, which if satisfactory entitles him to a certificate and the privilege of paying ten dollars more therefor.

The following is the certificate:—

ONTARIO, DOMINION OF CANADA.
PROVINCIAL LAND SURV'RS' BOARD OF EXAMINERS.
CERTIFICATE OF PRELIMINARY EXAMINATION.

This is to Certify, to all whom it may Concern, that John Smith, of the City of Toronto, in the County of York, hath duly passed his Preliminary Examination, in compliance with the provisions of the 4th Section of the Provincial Statutes, 18 Victoria, Chapter 83, and hath been found qualified for an admission as an Apprentice to a Provincial Surveyor in Ontario.

In witness whereof, we have signed this Certificate, at the City of Toronto, in the County of York, Dominion of Canada, the Eighth day of January, one thousand eight hundred and seventy-seven.

Thomas Devine, *President*,
Geo. B. Kirkpatrick, *Secretary*.

The candidate is then at liberty to search for a "master" in the person of some provincial land surveyor.

WHO MAY BE ADMITTED TO PRACTICE.

9. No person shall be admitted to practice as a Land Surveyor in and for Upper Canada or Lower Canada, until he has attained the full age of twenty-one years, nor unless he has gone through a course of Geometry, including at least the first six books of Euclid, and plain Trigonometry, Mensuration of Superficies, Plotting and map drawing, and is well versed therein, and is also sufficiently conversant with Spherical Trigonometry and Astronomy, to enable him to ascertain the latitude, and to draw a meridian line, and is conversant with the rudiments of Geology, and has served regularly and faithfully, for and during the space of three successive years, under an instrument in writing duly executed before two witnesses, or in Lower Canada under a Notarial *Acte*, as Apprentice to a Land Surveyor for Upper Canada, or Lower Canada, duly admitted and practising therein as such, nor until he has received from the said Land Surveyor a certificate of his having so served during the said period.

10. Persons admitted in one section of the Dominion may be admitted to practice in any other after six months of actual service as an apprentice.

11. It shall not be necessary for any Land Surveyor duly admitted to practice in any of Her Majesty's Dominions other than this Province, to serve under an Instrument in writing during three years as aforesaid, but it shall only be necessary for any such person so to serve during twelve successive months at actual practice, after which on conforming with all the other requirements hereof, he may undergo the examination by this Act prescribed.

12. No instrument in writing under which any applicant for admission to practice as a Surveyor claims to have served with some practising Surveyor for the period of three years, one year or six months (*as the case may be*) shall avail to authorize the admission of such applicant, unless such instrument, if executed before witnesses, or a notarial copy thereof if it be a notarial instrument, has been transmitted to the Secretary of the Board before whom the applicant is to be examined, within two months next after the date thereof, nor unless the fee mentioned in the Schedule to this Act was by the apprentice paid to the Secretary of the proper Board at the time of transmitting the Indenture or Articles; and the said Secretary shall acknowledge by post the receipt of all such instruments or copies thereof transmitted to him, and shall carefully keep the same in his office.

15. If any Surveyor dies or leaves the Province, or is suspended or dismissed, his Apprentice may complete his term of Apprenticeship, under an Instrument in writing as aforesaid, with any other Surveyor duly admitted. 12 V. c. 35, s. 3.

16. Any Surveyor may, by an Instrument in writing as aforesaid, transfer an Apprentice, with his own consent, to any other Surveyor duly admitted, with whom he may serve the remainder of the term of his apprenticeship. 12 V c. 35, s. 3.

Young men who wish to obtain the diploma of P. L. S., and at the same time acquire a fair education, usually take advantage of Section 17 of the Act which is as follows:—

17. Any person who after having first passed the preliminary examination hereinbefore required for admission to Apprenticeship with a Land Surveyor, has followed a regular course of study in all the branches of education required by law for final admission as a Land Surveyor, through the regular sessions for at least two years in any University in this Province wherein there may be organized a complete course of instruction, practical as well as theoretical, in Civil Engineering, Natural Philosophy, Geology and the other branches of education required by law for such admission as a land surveyor, and who has thereupon received from such University, after due examination a Degree or Diploma of Qualification as a Civil Engineer and Land Surveyor, may be received as an Apprentice by any Land Surveyor in Upper or Lower Canada, and shall thereupon only holden to serve as such Apprentice during twelve months of actual service, or, if he has passed through such University course of study in less time than two full years, then for such time of actual service as with the period spent by him in such University course of study suffices to make up the full time of three years; and after such actual service, such person shall, subject to the other provisions of this Act have the same right to present himself for, and to undergo the examination required by law, and, if found qualified, then to be admitted to practice as a Land Surveyor in Upper or Lower Canada, as the case may be, as if he had served the full three years' Apprenticeship otherwise required by law. V. c. 37, s. 1.

The writer was the second candidate for the Diploma of P. L. S. under this provision, C. McLennan, Village Engineer Hyde Park, Cook Co., Ills. being the first. The University Act as it was called, was never in favor with the Boards of Examiners and only four or five candidates under its provisions have presented themselves for examination.

There is no doubt that had the proper encouragement been given by the Examiners, that more young men would have availed themselves of the benefit of this act, and a far higher standard of intelligence and *respectability* would have been conferred upon the office of Provincial Land Suuveyor than now prevails, or ever can prevail, under the compulsory and unpaid drudgery that every surveyor's apprentice has to undergo for three years, with a "master" whose educational attainments are usually of the most limited character, and to whom the apprentice's labor and premium are the most profitable contributions to his income. The Board of Examiners of Ontario—without they have improved of late years,—as a committee of experts to whom were entrusted the interests of an honorable profession and whose duty it was to seek to elevate it to higher and higher standards of excellence and honor, by the encouragement of more liberal education for its candidates, and by a more honorable and liberal treatment of candidates who came to them for examination after long-tried service as engineers, have failed most grossly.

In answer to our correspondent "B" of Macomb, Ill. whose communication appears on page 163 ENGINEERING NEWS, it is our opinion that the corners on the Township lines should be re-located satisfactorily, and afterwards the corners of the interior section.

The Presidents of the Banks and Insurance Companies of New Orleans are putting their shoulders to the wheel and in conjunction with the public press of that city are endeavoring to encourage the subscription to the second mortgage bonds in aid of the New Orleans and Pacific Railroad. The amount needed is $675,000, with which it is proposed to finish the grading, bridging and laying of ties on the line from Bayou Goula to Marshall and Shreveport, Texas. If this loan is not effected the road cannot be built and a large part of the trade of Texas, yearly growing of more value will be lost to New Orleans by being diverted to Galveston, St. Louis and Chicago.

The reports of progress at South Pass are meagre enough nowadays, but according to some of the New Orleans papers, failure is written upon the great work of Captain Eads, the evidence used being the preference of sea captains for the Southwest Pass. We published some weeks ago the sixth report upon the work, by Major Comstock, U. S. Engineer, and will endeavor to keep our readers posted on all authentic information which reaches us. Whether the experiment succeeds or fails we hope to see Captain Eads and the engineers under him re-imbursed for what they have done or may do in solving the question for securing a permanent deep channel from New Orleans to the Ocean. Our views concerning the jetties have been pretty fully expressed heretofore and our columns are open for the advocates and opponents of the improvement, but we do not think it necessary to reproduce all the items which the partisan papers of New Orleans are careful to publish for or against, upon the reports of every skipper who takes a sounding.

New Orleans is undoubtedly the natural outlet for the cotton and grain of Texas, South Arkansas and Northwest Louisiana, and it is only by the superior enterprise and energy of the merchants and other business men of St. Louis, Chicago and Cincinnati, that this trade can be taken from that city. From Shreveport to St. Louis it is about 600 miles, and then nearly a thousand more by rail to the seaboard, while by way of the proposed N. O. & P. R. R. it is but little more than 300 miles from Shreveport to New Orleans, where are

to be found all the conveniences for handling cotton and placing it at once on board vessels for conveyance by cheap water rates to any seaport in the world. It is also claimed that the grades and curves of the proposed railroad are easier than those of the Texas Pacific, and Southern and Iron Mountain Roads, and that much lower freight rates can be maintained than can be over these roads. Now that the political troubles of New Orleans are largely set at rest it is a matter of necessity to that city to show by the enterprise of its citizens that it believes in its own future by giving encouragement to public works that will benefit it and thus by restoring its former prestige among the great cities of the Union, invite foreign capital and enterprise to locate there and by their help secure to their city what must be lost if a timid and hesitating policy be adopted by those who are most interested.

WEST CHICAGO GAS.

Some months ago there was a general lowering of prices of gas all over the country; the gas companies of Chicago had to yield in some measure to the pressure, but one of the companies holding a contract made with a City Council seven years previous, and for a term of ten years refused to lower its price to the city, and when measures were taken to light the city lamps with oil, an injunction was asked to restrain the city from breaking its contract to pay $3.00 per 1000 cubic feet of gas. Judge Drummond, of the U. S. Circuit Court, on July 2d, refused the injunction, and the case being quite interesting we quote the judicial opinion in full as follows:—

In May, 1859, the City of Chicago entered into a contract with the Chicago Gas Light and Coke Company to furnish the city with gas for ten years, viz.: till May, 1869.

In February, 1855, the People's Gas Light and Coke Company was incorporated, and was authorized to manufacture and sell gas to the City of Chicago, and to erect all necessary works for that purpose. In April, 1862, with the assent of the city, the Chicago Gas Light and Coke Company assigned all its interest in the contract of 1859, as to the West Division of the city, to the People's Gas Light and Coke Company, and from that time the latter company, until May, 1869, when the contract of 1859 expired, performed the obligations of the Chicago Gas Light and Coke Company under that contract. In 1869, then, the People's Company had the means of manufacturing gas, and was selling it to the city as the assignee of the Chicago Company.

By an amendment made in 1865 to the charter of 1855, the People's Company was authorized, with the consent of the city, to lay down all necessary gas pipes along the streets and public squares. This power seems to have been exercised by the company from 1869 to 1876, and until the controversy which has given rise to this litigation.

By its charter the city had authority to light the public streets—and it is to be inferred, the public buildings and offices—and to levy and collect a tax for that purpose. The power to provide the necessary means for lighting the streets, buildings and offices, either by the construction of a gas manufactory or by contract, would seem to follow as of course. But it can hardly be presumed, in the absence of any restrictive legislation on the subject, that it was intended to confine the city of Chicago, as its source of supply for gas, or for light to the People's Company or to the Chicago Company. These means were furnished, but they were not exclusive.

In 1869 the charter of the city contained a provision that no contract should be made by the city involving any expense, unless an appropriation was previously made concerning such expense. And the Comptroller was required in May of each year to submit an estimate of the amount necessary to defray the expenses of the city for the current fiscal year.

This provision of the charter does not seem to have been construed as a prohibition to the execution of contracts extending over one year, even where the appropriation did not meet fully the expense of the contracts, and it would be difficult to maintain that this construction is unsound. The language must obviously be applied to the subject matter of the contract, as understood by the Legislature, viz.: To those matters where the terms of the contract and the time of its execution were practically within the reach of an appropriation once made. The construction of tunnels, of waterworks, of public buildings, including gas-works, of deepening summit levels, and many other matters within the general scope of the powers of the city, may require more than a year to complete and must necessarily involve more than one appropriation. And yet in view of the manifest intention of the Legislature, it may be doubted whether the city would be authorized to execute any of these general powers without an estimate first made of the expense to be incurred.

But if it be admitted this is the true meaning of the prohibition, it is clear the purpose of the Legislature was to limit the City Council to the actual necessities of the particular case, and the question to be determined is whether there was a reasonable necessity on the part of the City Council to extend the contract in controversy here, and which will now be mentioned, for ten years from its date, there being no appropriation made commensurate with the obligations of the contract.

We will waive the question connected with the right of the plaintiff, a stockholder of the People's Gas Light and Coke Company, to come into this court for equitable relief, and also the other question, whether there is not a complete remedy at law for a breach of the contract, if valid, against the city, questions not free from difficulty, and come to what is the principal controversy between the parties—the contract between the city and the People's Company.

On the 5th of October, 1869 in pursuance of authority given to that effect by the City Council, the Mayor and Comptroller entered into a contract with the People's Gas Light and Coke Company, by which the gas company agreed to supply the streets and public buildings and offices of the West Division with gas for $3 per 1,000 cubic feet, and the city agreed to take and use the same for the streets, buildings and offices, and pay the price named. The contract was to continue in force *till the 1st of April, 1879.*

The contract contains other stipulations not material to this controversy. But it must be stated that the contract assumes that the gas company had the means of complying with its obligations. It is not the case of a contract made by the city with a company which, as a consideration for making the contract with the city, was to construct and maintain gas works where there were none before. On the contrary, it is to be fairly inferred, that the company had as authorized by its charter of 1855, and its amendment of 1865, constructed gas works before October, 1869, and had the necessary appliances to execute the contract on its part. It is true, the bill alleges, and we may presume, that in consequence of the making of the contract, the company enlarged its works and made considerable expenditures; but it nowhere appears that this was a condition precedent to the execution of the contract, as that the city declared if this shall be done, the contract shall be executed, or that the company said, if not done, then it will not be a party to the contract.

This then being the condition of the parties as to the subject matter of the contract, had the city the capacity to make it? I think it had not.

It is not necessary to refer to the numerous cases cited on the argument. In my judgment they establish by a preponderance of authority, that a municipal corporation, under the powers conferred on the city of Chicago by the Legislature, and under the circumstances existing here, had no right to make a contract with the People's Gas Light and Coke Company to pay for the use of gas for so long a time. And I think on principle the same conclusion must be reached.

The officers of the city—the members of the council—are trustees of the public. They are clothed with authority to legislate upon public interests. There can be no doubt that the right to regulate the lighting of the strees and to furnish means for the same by taxation, is in its nature legislative power. It concerns the whole public of the city. The effect of the contract in question by the city authorities in October, 1869, if valid, was to bind their successors for *ten years*, as to those matters of legislation. If it be conceded that the power existed, as claimed, then it practically follows that at the end of the term, in 1879, a contract may be made by their successors without limit, and which may bind the public indefinitely. I am unwilling to sanction a principle which, in a case like this, would lead to such results. The safer rule is to hold the officers of a municipality to a rigid accountability in the discharge of their trust. In all cases of contracts to run for years, the authority to make them should be clear; because they involve pecuniary liability and it is a tax upon future property-owners of the city.

To sustain the contract between the city and gas company in this case would encourage the making of such contracts in the future. It would place it in the power of companies, whose interests were to be affected by them, to multiply them and continue them when the public interest demanded they should cease. To condemn it is to prevent, so far as it may tend to produce that result, the use of influences which look to private rather than to public profit. It is better that all parties should understand there is a limit to the power of municipal bodies in such cases.

I hold, therefor, as a matter of strict legal right that the contract of October 5, 1869, was unauthorized, and the motion for an injunction against the city to prevent interference with lamp-posts, service-pipes, etc., will be denied.

But the opinion of the court, even on this application, must be incomplete, without considering the case in another aspect.

It must be admitted the claims of the gas company against the city seem in some respects to be founded in a strong equity.

The city assumed to treat with the company on the basis of right to make the contract. The latter may therefore be pardoned for recognizing the authority claimed. For several years the city conceded the validity of the contract by paying for the gas the stipulated price. It is only within the last few years, and after the cost of producing gas had been greatly reduced, that any active efforts were made by the city to deny the obligations of the contract. If the cost of its production had been increased, we should probably never have been troubled with this litigation.

The company has made large expenditures for additional works. Many miles of mains and many service pipes have been put down. These have been much extended in parts of the city where there has been, up to the present time, no adequate return, owing to the sparseness of population there. It is alleged this has been done by the company at the request of the city, and that in consequence the company has been subjected to great loss caused by condensation and leakage of gas from the pipes not in use and not required for use when they were put down.

The contract by its own limitation expires in less than two years from the present time.

In view of these circumstances it was suggested at the hearing of the motion for an injunction that some satisfactory arrangement should be made between the parties, or by reference to others. The Gas Company was the means of supplying gas. The city needs it. It would seem as though they could deal with each other better than any one else. If the purpose of the city was to do nothing until the validity of the contract was ascertained, that is accomplished so far as the opinion of this court can determine it. And, therefore, as we are now only deciding a preliminary motion in the case, it does not seem improper to renew the suggestion that was made on the hearing of the motion, for the equity of the plaintive appears so strong, the acquiescence of the city in the contract so long continued, that if I could hold it binding on the city because of the acquiescence I should feel inclined to do so, but the fact that the rights of the public cannot in this way be affected, prevents this, and nothing remains to be done in the present stage of the case but to express the wish that the suggestion of the court may be adopted by the parties.

CHICAGO PUMPING ENGINES.

The test of the pumping engines lately constructed for the West Side Pumping Station of the city of Chicago, Ill., by the Quintard Iron Works of New York, was commenced in the month of January last, but in consequence of the condition of the boilers, from the presence of scale and mud, extreme cold weather and injudicious firing, the engines failed in the required duty of 90,000,000 ft. lbs., although they discharged more than the required volume of water, of 30,000,000 U. S. gallons in 24 hours.

The Commissioners upon this occasion were: Moses Lane, of Chicago; Chas. H. Haswell, of New York; Henry Warrington, of Chicago; Chas. Hermany, of Louisville; and T. J. Whitman, of St. Louis.

The boilers have been cleaned, and more reliable means effected of measuring both the flow of the water delivered and the height to which it was raised, than upon the previous occasion, the test was renewed on the 18th day of April, under the direction of Messrs. Lane, Haswell and Warrington, and continued for 48 hours with each engine, with the following results:

ENGINES.

	No. 25.	No. 26.
Period of operation,	48 hours.	48 hours.
Pressure of steam at boiler,	61.77 lbs.	60.86 lbs.
Pressure of steam at engine,	59.25 lbs.	60.25 lbs.
Point of cutting off,	30 to 33 in.	30 to 33 in.
Revolutions,	11.177 per min.	10.63 per min.
Temp. of feed water,	124° 4'.	131°.
" external air	45° 9'.	60° 48'
" engine room,	75°.	77° 94'
" fire room,	77°.	73°.
Coal consumed(Lackawanna broken lump),	42,400 lbs.	43,028 lbs.
Av. height of water in standing pipe,	155.83 ft.	159.11 ft.
Av. height of water as indicated by pressure-gauge at delivery,	157.06 ft.	159.34 ft.
Feed water per hour,	9779.5 lbs.	10059.4 lbs.
Width of weir,	7.94 ft.	7.94 ft.
Av. height of weir	.9787 ft.	.9543 ft.
Volume of leak in weir-box of flume,	5768 cu. ft.	5768 cu. ft.

The volume of water discharged, computed by Francis's formula, and the duty developed for each engine were as follows:

VOLUME.

$$Q = 3.33 \times .9787^{\frac{3}{2}} (7.94 - .2 \times .9787) \times 172800 = 4314617.28 \text{ cu. ft}$$

Leakage of weir-box and gate, " 4768. "

4320385.28 "

In 48 hours = 16159363 gallons in 24 hours.

DUTY.

Hence, $\frac{4320385.28 \times 62.4 \times 155.83}{\frac{42400}{100}} = 99066718.27$ lbs. of water raised 1 ft. in height, with 100 lbs. of coal.'

The engines are vertical compound, with over-head beam.

PRINCIPAL DIMENSIONS.

High-pressure cylinder, diameter 48 in.
Stroke of piston, 6 ft.
Low pressure cylinder, diameter 76 in.
Stroke of piston, 10 ft.
Pump, 51 in.
Stroke of piston, 10 ft.
Fly-wheels, each 32 ft. in diameter and 60 tons in weight.
Beam, 36 ft. in length and 7 ft. in depth.
Boilers, 4 cylindrical, fire tubular return.
Diameter of shell, 6 ft 6 in.
Length, 16 ft.
Tubes. 100 of 4 in. in diameter and 16 ft. in length.
Drum, 3 ft. 6 in. diameter and 8 ft. in height.
Grate surface, 116 sq. ft.
Average consumption of coal per hour, 890 lbs.
Average evaporation per lb. of coal, 11.12 lbs.

—*From the Journal of the Franklin Institute.*

THE SHAPING OF TOWNS.

The effort that is making for the systematic improvement of the town of Williamstown, of which we spoke a week ago, is in its systematic character and breadth of aim so unlike what is common to do in management of towns, and so suggestive of the kind of forethought which might be used to improve the condition of almost all of them, great and small, that it tempts one to moralize on the neglect under which most of our towns are allowed to grow up and the inconsiderateness with which they are planned. The subject is one that concerns every person in the community, and yet one of which nobody ever thinks; while the evils that result from the neglect of it are very serious, and often entail an unpardonable sacrifice not only of natural beauty, but of permanent convenience. A heavy burden of expense is often the result of sheer neglect to provide in advance for the most obvious needs; and all travelers can point to towns in which natural opportunities have been recklessly thrown away or natural beauties perversely sacrificed. The greatest enemy is private "enterprise," which for the sake of momentary advantage and under guise of personal liberty is often allowed to entail ruinous injury upon neighboring property, and upon whole towns permanent deformities which it would seem that a tolerable forethought and a reasonable exercise of public authority were sufficient to prevent.

It falls to Americans as to no other people in the world to take the responsibility of deliberately laying out their towns. Every year sees some new one founded, which soon accumulates a considerable population; and the experience of older cities, showing how difficult it is to cure the evils of faulty growth when towns have become large and densely built, ought to teach us to be careful not to so plan them that they will by and by have to be replanned It is not only the old cities of the world, which grew into shape under a different civilization from that of our day, that have been obliged to undertake very serious and expensive changes to suit them to modern uses. American towns, which in comparison are the children of yesterday, have hardly reached a mature growth before it is found that much of what has been done in laying them out has to be undone, and that much of what cannot be undone is permanent injury. The city of Paris is a standing example of the appalling expense that may be incurred in adapting an old city to modern uses. It is true that the changes of centuries in the ways of civilized life are not to be forecast; but the experience of two or three generations in American towns shows that costly alterations have constantly to be undertaken which a reasonable forethought might have provided for in advance. Chicago had hardly become a town of some importance when it was found that to get even a tolerable drainage, it would be necessary to raise the level of a great part of it by several feet. The inhabitants with characteristic enterprise undertook the work as soon as they saw the need of it; but already, we believe, they wish it had been carried further. In most cases it is the natural characteristics of the sites that determine the changes that have to be made at last; and these characteristics can be as fully seen in the beginning as at the end. These and the means and directions of communication with their surroundings compel in a great degree the ultimate form of any city. A considerate observer could have foreseen a hundred years ago, as well as the inhabitants see it today, that the town of Boston, with its close connection with Charleston on the north, and its access from the main land by the neck on the south, would absolutely require a great continuous thoroughfare from one of these regions to the other: yet it is only within two or three years that such a thoroughfare has been carried out by expensive alterations of the oldest part of the city. New York is a marked example of the irresistibly controlling influence of situation. Set as it is on a long narrow island, a fine harbor opening down from the southern end, and with a deep waterway on the east and west sides, it was a foregone conclusion that if it grew to be a large city the shipping and commerce would advance up its sides, and that as fast as this happened the tide of business would fill its narrow width from river to river, rising to the upper stories of its houses, and drive the residences northward before it. It was inevitable that the main avenues should run north and south, and that the residence quarters should steadily retreat to the upper end of the island and to the main land. In fact, in that city there were but two or three things in which the inhabitants could fail to obey the necessary laws of its growth, and could go wrong. In two of these they did go wrong. One was in the provision of a proper system of sewerage, of which in spite of almost unequalled advantages in the disposition of its surface New York made a wretched mess; and the other in not reserving means of quick railway communication from end to end of the island. A third critical matter was the reservation of proper breathing-space in the form of a park; and here the people of the city were wise enough to take the thing in hand just at the right time, and provide themselves with a park, ample, well-placed, and unspoiled, that will always be priceless to them.

It is not often that the position of a town so imperatively dictates its plan as does that of New York; but it is less often still that there are not some determining influences in its topography which will greatly control the manner of its growth, and which ought to have careful study in laying it out. Chicago, for instance, has probably as neutral a site as can be found in any city of consequence: yet there the position of the lake shore and of the forked stream that divides it, the directions of the great lines of communication with other cities and with the producing regions of the neighboring country, are enough to have fixed the leading points in the disposition of the town, and probably enough, if they had been carefully studied, to give indications for a much more convenient planning than the present. It is only in such towns as are dropped at random upon the flat and featureless prairies along our western railroads that the natural surface has no advantages which deserve study; and even then the winds and the sunshine remain to give their hints. But in the ordinary course of civilization, such characterless sites are not the ones to which populations cleave. Some convenience of access by a natural highway, or some advantage of ground, or sometimes mere beauty of position, determines the placing of a city. The directions of the valleys or ridges which form highways or barriers, the points at which routes reach it from different directions, every slope of a hill or curve of a bluff, the directions of the winds and of the midday sun, all these are elements which should be taken carefully into account, and may give valuable suggestions to serve the convenience of business and residence, or if not these, still the high convenience of beauty. But the surveyor who lays out a new town cares for none of these things. He plots his rectangular streets, so many to the mile, on a sheet of cross-section paper, and applies them to his site. If elevations and slopes come in the way of his right angles or his grades, he pares off the hills and fills up the plains till he has a *tabula rasa* to work upon. The popular idea of a model town is one all whose streets are at right angles and whose whole territory is as flat as a floor. Now, leaving beauty out of the question, in spite of certain manifest small advantages a rectangular town is not, on the whole, a convenient town, and involves in the aggregate an enormous waste of time in going round long corners to get from one point of it to another; and a flat town is, other things being equal, an unwholesome one.

When towns are left to grow up wild, as most of our older towns have grown up, they naturally adapt themselves to their circumstances, and are seldom without a considerable degree of both convenience and picturesqueness. They are nevertheless subject to all sorts of untoward accidents, and very likely to be permanently injured by distorting their growth to suit momentary and unimportant exigencies, or in favor of private schemes. Instances are many where the best parts of a town for residence or for business uses have been allowed to fall into squalid degradation, to remain a permanent disfigurement and injury, or to be afterwards reclaimed at wasteful expense. It is but a few years since London resolved at a great cost a part, and only a small part, of her river-front in the very heart of the city from dirty inaccessibility. The rest is still a disgrace to her. She is now attempting to open a new avenue in the same neighborhood to connect two of her most fashionable and busiest quarters,—Oxford Street and Trafalgar Square,—but to do this she must cut through one of the vilest quarters of the town, the famous parish of St. Giles, which yet defiles this favored region. All our readers will remember instances where some speculator has permanently injured or ruined a desirable neighborhood, or where a few dirty cabins, inconsiderately allowed a lodgement, have repelled the better residents from the finest part of a town, and permanently devoted it to filth and neglect. Most of our cities sooner or later wake up to the fact that they have missed their opportunities, and allowed things to go wrong which they have got to set right at an excessive cost, unless indeed they are frightened away from all attempts at improvement by the difficulty of it. And finally, when they do set to work, they do a little bit here and a little bit there, one administration undoing what another had begun, or passed to a different scheme, or else the authorities stand at bay amid the attacks of a hundred private interests, all clamorous for different things till the labor of improvement becomes herculean.

These difficulties could be in a considerable measure guarded against if they were looked out for carefully and continuously. A great proportion of the annoying things that have to be undone, and the still more annoying things that cannot be undone, might be prevented. Unhappily, since what is everybody's business is nobody's business, there is nobody to look out for these things. Under strong, permanent, and personal governments such things are provided for; it will be one thing more to the credit of the habit of local self government when they are cared for among us. The whole subject of the distribution of people in towns, their means of transit, their thoroughfares, parks, places of business and residence, deserves serious study, and should no more be left to the mercy of accident than should draining or lighting; but it has been almost entirely neglected. It is a matter which it seems to us might well be the special charge of distinct officers, commissioners, conservators, or what not, who should be beyond the reach of party influences or frequent change, and who should be specially trained to watch over the growth, development, and improvement of their towns. If the grading, drainage, paving, cleansing, and policeing of towns are worthy of careful and systematic control, so are also the general shaping of the towns, the preservation or destruction of the natural features of their sites, and the distribution of their population and residence. Just what are the proper limits of public interference in such matters is a political question upon which we cannot venture; but public neglect has shown itself to be both costly and pernicious.—*The American Architect and Building News.*

TOWN ARCHITECTURE AND MODERN PROBLEMS.

Let us now consider the peculiar requirements of modern cities, as they present themselves to the architect.

Any large assemblage of people in one place must, of course, give rise to difficulties as regards the provision of healthy dwellings. A cottage, standing in its own grounds, may long be deficient in many things, without causing more than a passing inconvenience. Soon oth-

er cottages are erected near it; these press one upon another, till waste spaces are covered and houses touch. The ditches are defiled, springs are polluted, verdure is banished, and the air is thick with smoke. The former country hamlet is now the centre of a great town, the only home of its poor, and only too often the hot-bed of crime and vice. What can architecture do in such a case, but wait and plead, until the public sense of responsibility is roused to insist on the necessity of wholesome habitations for all classes? The architect may then point out the advantages that may accrue to the entire community by making arrangements which, while removing reproach, may add interest, convenience, and beauty to our cities.

But it is with other classes of buildings than the houses of the poor that we have to deal. While these need not be ugly, they, cannot, of course, add much to the architectural ornaments of a great town. Such ornaments must be looked for in the public buildings, the banks, mercantile offices, and the dwellings of the wealthier inhabitants. On all public improvements, it has long been admitted, that the public has a right to speak. But though the principle has been admitted, the application of it has hitherto been far from complete; and even in utilitarian matters, it is to be feared, that some terrible catastrophe may one day startle the public mind by the revelation of deficiences in our legislation, as applied to the buildings in large towns.

Take, for example, the case of theatres, and other places of public assembly. It was but lately that hundreds of victims perished miserably at the Brooklyn Theatre in New York; and there are theatres in London which I never enter without anxiety, or quit without a feeling of relief. We have no public officer who can insist on the sufficiency of entrances and exits, proper width of passages, isolation from adjoining houses, and such matters. Stairs in new buildings must indeed be of incombustible materials; but they are too often narrow, ill-constructed, badly planned, and inconvenient, and the public has no choice but to submit. The evil is not only great but growing, for, in these respects, it is often our newest structures which are the greatest offenders.

Of course, when anything is wrong, people are apt to cry out on the architect as if he were responsible, but this is not right. Wherever rents are high, as in London, land is dear, and the temptation to a lessee to recoup himself in every legal way, is irresistible. A difference of a yard in the width of a passage may give an extra row of seats, worth hundreds a year to the manager; and he knows that the public, ever thoughtless when its amusement is concerned, will rush to a theatre, heedless of its hidden perils. I have mentioned theatres, not because they are the only buildings for which public control is needed, but because they are among the most obvious specimens of the class, which includes concert and lecture-rooms, churches and all places where the public assembles in large numbers.

We know how careful the Romans were as to the corridors and exits of their theatres; and the work will remain as a guide to future ages, after many of the flimsy structures of to-day have totally vanished. If the architect be, as I have said, greatly interested in these questions, they are to the public of vital moment, and it is for the public to deal with them through its chosen representatives. It is useless for an architect to provide exit in his plans, which are afterwards built up and disused, because each doorway is a source of expense to the management, and there is no encouragement to design good houses, as long as people prefer low rents to healthy homes.

In country places, where buildings are, perhaps, placed in spacious parks, isolated from all contact with others, it may, doubtless, be contended that any regulations in the interest of the public are uncalled for, and would be an unnecessary interference with individual liberty; but in towns the case is different. Here a man cannot live only for himself; he must so enjoy his own rights as not to injure his neighbor's. The principle of building regulations has long been conceded, and it only remains to determine their extent and application. Such regulations are, indeed, essential to the well-being of the community in modern cities.

Another important point in our civic architecture is the selection of materials, as bearing on both the artistic and the utilitarian side of our art. We have most of us admired the timber houses, so much in favor with mediæval architects, and some are doubtless found to regret their disuse, and to declaim against any prohibition of such a manner of construction in our modern towns.

A careful study of old timber houses will show us that their beauty depends on the sensible application of true principles of construction and decoration, designed with a careful recognition of the essential characteristics of the material employed. The forms of all corbels, windows, and roofs, are such as are suitable for wooden construction and for no other. But we do not find that wood was chosen by our ancestors except from necessity. It was at hand in the great forests and woods of a sparsely populated country, it could be worked with simple tools, and quickly erected. Carriage was easy for it as compared with more solid and weighty materials: it presented, in fact, the cheapest and easiest method of house-building; it was consequently generally employed, and the old builders brought to bear upon its construction all their skill, as well as their knowledge of art, for its ornamentation.

The crowding of hundreds and thousands of houses into cities, such as London, could not be foreseen; but I have shown, in one of my former lectures, how soon the civic authorities became aware of the danger of wooden buildings, and have described the simple remedies which they prescribed.

In modern architecture wood bears a more subordinate place, and in so treating it we do but follow the same principles of common sense which guided our forefathers. They built chiefly in wood because they had practically no choice but to do so. We have materials of all kinds brought to our doors, and if we attempted to employ wooden construction, as they did, the material would soon reach a famine price, and ultimately fail us. Thus, while we may not copy their practice, we may well be guided by similar principles, and may study in a similar spirit, the qualities of the materials we employ, with a view to that rational application of ornament which has ever distinguished good art from bad.

Having already spoken to you on the question of materials, and their effects on originality of architectural design, I will not dwell again upon that part of the subject. As, however, I have referred to danger from fire, I may, perhaps, be allowed to say a word as to the use of incombustible materials in our dwellings and public edifices. We do not need to be reminded how terrible an enemy fire is to architecture, and to human life. We know what it has done in former times to London, and the misfortunes of Chicago and Boston are recent. Hardly one of our theatres has escaped, and few even of our cathedrals have not been injured or threatened. It is, therefore, unnecessary to say that architects are bound to study this question, which is far from simple. Where a great body of fire exists, as in a warehouse stored with inflammable substances, such materials for supporting fire bear so large a proportion to the constructional portions of the building that the latter are simply overwhelmed, and wood, stone, iron, marble and brick are involved in one common ruin. This has led some persons to think that a fireproof building is impossible, and, perhaps, in the strictest sense it is. Not so, however, practically, in the vast majority of cases, with which architects have to deal. Because iron and stone have yielded, when exposed to intense heat, it does not follow that they may not be employed with advantage when all the circumstances of each case have been fully considered, and I cannot subscribe to the doctrine, that in public buildings, it is better that the stairs should be made of wood, which will burn, rather than of stone, which will not.

There is and should be no difficulty, at any rate, in so constructing our domestic architecture, that the existence in our houses of any large body of flame sufficient to cause danger to materials not in themselves capable of ignition, should be a physical impossibility. Unfortunately, this is seldom or never done, from causes to which I have already adverted. Houses are built to last for a term of 99 or even 80 years, and their builders prefer to pay premiums to fire offices rather than to invest additional capital in their buildings, so as to render them permanently safe from danger by fire.

The application of incombustible materials to ordinary buildings is still in a backward state in England, more so by far than it is in France, for example; and with reference to theatres it has scarcely been seriously attempted. In these buildings the stage and its appurtenances must probably be always, more or less, inflammable, although chemistry may help us in this respect; but, as regards the auditorium, no difficulty exists which is not to be surmounted by any skillful architect, and a dangerous fire in this portion of the building ought to be an impossibility.

It is, indeed, even now panic, rather than actual fire, that constitutes the most terrible danger, in case of accident; and if the audience were conscious that the construction was, as it should be if they saw wide corridors and ample staircases, of material which will not burn, we should never again have to deplore such a calamity as the American catastrophe, already adverted to.—*Prof. Barry in the Architect, England.*

CORRESPONDENCE.

CHARLESTOWN, MASS., *June 27, 1877.*

Editor ENGINEERING NEWS:

SIR:—Please correct the following misprints occurring in my letter in your issue of the 9th inst., relative to DuBois' "Graphical Statics."

The expression "$2\,(1+\frac{k}{2})+\cos^2\alpha$" should be

$2\,(1+\frac{k}{2})\,\alpha\cos^2\alpha$,

In the correction for formula (72), for "P" read f.

In the second equation for M_0 the factor "$(3a+2)$" shoulb be $(3a+z)$.

In the next equation the term "$+a^2z^2$" should be $+18a^2z^2$; and the general formula should be

$$=M_0\frac{f'z\,(3\,a\pm z)\,(a\pm z)^2}{32\,a^3}.$$

In the table the number corresponding to M_0 and -0.1 should be -0.007062.

In the equation for H at the bottom of the page, the factor "$(\pi-6\,\pi\,k)$" should be $(\pi-5\,\pi\,k)$.

Yours very truly,

C. W. KETTELL.

A correspondent writes from Kansas City, Mo., for the following information, concerning which we would be pleased to hear from any of our readers who are familiar with the subject of steam engineering:

KANSAS CITY, MO., *June 22, 1877.*

Editor ENGINEERING NEWS.

SIR: If you can conveniently give me the answer to the following proposition I will thank you for it.

What is the actual effective horse power of an engine cylinder 14x24 in. stroke, 100 revolutions per minute, and 70 lb. steam?

I want, if possible, to get a simple formula which can be understood by common people, *i. e.*, not practical or theoretical machinists or engineers, to be used in our business in connection with water works for horse-power. You will much oblige by giving such a formula and figures in detail. J.

In answer to our enquiries we have received the following:

Editor ENGINEERING NEWS:

Your favor of the 26th is received. I cannot give the mean effective pressure from the indicator diagrams, as there are none. The 70 lb. steam means pressure in the boiler, revolutions 100, cylinder 24x24, steam cuts off 4 in. from end of cylinder; think this latter will give you what you want. Will thank you very much for an intelligent formula. J.

LUXURY ON THE RAIL—THE DIFFERENCE.

We have been frequently asked: "What is the difference between a railroad dining car and a Pullman Hotel car?" That there is a vast difference is well known by those who have had occasion to use either; but the untraveled public are not fully advised as to the points of difference. The old-fashioned railroad eating-house is, alas! too well known: its peculiar, hastily-eaten meals have been partaken of by too many thousands to be forgotten. The dining car, then, is this well-known eating-house placed on wheels, attached to the train at the usual meal hours, and hauled along for thirty, forty or sixty miles, until the meal has been served, when it is set off on a side-track, and is by the next train hauled back to its starting point, and so it runs a few miles for each meal. To get meals in this car the passenger has to work his way through the train *while it is under full motion*—pass from car to car, running the risks of falling between the platforms, and finally finding the car at the rear of the train. Then comes the meal, which must be hurried through with to give chance for other hungry passengers to take your place, and you must force your way back to your seat, and again run the risks of your platform passage while the train is at full speed. In such cars you pay seventy-five cents for each meal, even if you take or need only a cup of coffee and a cracker. Bear in mind, in no case do these dining cars accompany the train from starting point to destination. They are always "cut off" and taken on as we have

described. With the Pullman Hotel car the case is different in every respect. These cars are sixty to sixty-six feet long, have sixteen wheels under each, are built strong, so as to insure steady, quiet running, without the usual unpleasant side motion. Each Hotel car contains, in the order named, the following compartments:

1st. A cosy, neat and clean little kitchen, fitted up with a range, an ice and meat box, rows of shelves covered with bright silver and brighter glass ware, and all the appliances needed for preparing a sumptuous meal.

2nd. A compact China and glass closet, in which is kept the table ware and table linen, cutlery, etc.

3rd. A passage way, cutting off the kitchen and China closet from the rest of the car, and forming an air chamber to prevent the smell of the cooking victuals from reaching the saloon portion of the car.

4th. The grand saloon. This is fitted up with twelve, fourteen or sixteen sections, with space for tables between each, and in these the meals are served. You, while on this car, own the space you occupy as much as you do your room at home, and no one can hurry you while at meals, nor are you forced to give it up to allow any other person to occupy it. At night, as if by magic, this saloon is changed into a boudoir, and here your couch is prepared, and here you rest yourself isolated, and as seperated from your fellow-travelers as you would be in your own bed-chamber.

5th. An elegant drawing-room, for six or eight persons. This is found alone in these magnificent cars. In it you and your family or party of friends may be as secluded as you please, or you can slide open the end and have the company of those in the grand saloon.

6th. Charmingly-arranged lavatories are partitioned off and arranged in two distinct compartments for the separate use of ladies and gentemen. These lavatories are supplied with fresh water, clean towels, combs brushes, and, in fact, everything the most dainty may desire for the perfect performance of an elaborate toilet.

7th. Then follow conductor's and porters' rooms, linen clothes, etc., etc.

It will thus be seen that this car is, as its name implies, a perfect modern hotel, with all of its appliances and comforts complete. This car is taken on at the commencement of the journey, and is part of the train to its destination. In it you get your sleeping compartments and your meal accommodations, while neither encroach upon the other. Envious dining-car employees, who are paid to decry this form of Hotel car, cannot, with anything like truth on their side, give any valid or conclusive reasons for preferring the dining to the Hotel car, and they only chatter in favor of their dining car because they are paid to do so. These Hotel cars have run from New York to San Francisco and back with the Emperor Dom Pedro—with Jarrett & Palmer's party, that traveled at almost lightning speed—with many a party of California bonanza kings; and all join in pledging their honor that the cars are incomparable.

Two lines of these celebrated cars run between New York and Chicago, and one line only between Chicago and Omaha. It may be needless to say that this last named line runs over the steel track of the *Chicago & North-Western Railway*. That these cars are attracting a large share of the California travel, both ways, might easily be conjectured. Any road deserves to be patronized that is enterprising enough to give the traveling public such facilities as are freely tendered by the *Chicago & North-Western Railway* on its California line.

We have neglected to say that, in these Hotel cars, the meals are *a la carte*—you pay for what you get, and nothing more; and this at very reasonable rates.—*The Tribune, April 7th '77.*

These celebrated Hotel cars are now running regularly between Chicago and Council Bluffs over the Chicago and North-Western Railway—No other road runs Pullman Hotel cars, Pullman Dining cars or any other form of Hotel, Dining or Restaurant cars *through* between Chicago and the Missouri River.

NOTES.

It costs only twelve cents per bushel to ship wheat from San Francisco to Liverpool, a distance of 12,000 miles. It costs eighteen cents per bushel to ship wheat from Chicago to New York by rail, though it is only half as much by water.

It is definitely decided that the Governor will appoint as commissioners to locate and build the new Southern Illinois Penitentiary, General John G. Foudt, of Carthage, Hon. Isaac Clements, of Carbondale, and R. D. Lawrence, of Springfield.

"The road and bridge tax levied for any given year is legally applicable in payment for labor performed and expentitures made on roads and bridges during that fiscal year, and cannot rightfully be applied to any other purpose, even to the payment of prior indebtedness."—80 Ill., 587. Those "in authority" will please make a note of this fact.

By direction of the Secretary of war a board of engineers, to consist of Colonel J. H. Simpson, Major C. R. Luter, and Captain W. H. H. Benyaurd, has been ordered to assemble at Vicksburg, Miss., on the 17th of July, 1877, or as soon thereafter as practicable, to examine and report upon the most advisable means of preserving the water front of Vicksburg and of arresting the danger which appears to be apprehended from the cut-off opposite that city. The board will also submit such estimates as may be thought advisable to present to the early consideration of Congress.

A $1200 "wing" is being added to the Ladies' College at Whitby, Ont. The wing will be called Rysoron Hall.

Work on the Craig St. Tunnel, Montreal, is stopped for the present. $1500 is appropriated for opinions of Engineers on the undertaking.

The contracts for the works for the drainage of Hochelage, Quebec were given out June 28. The tenders for excavations ranged from $5,000 to $15,000, and the party putting in the former tender got the job.

The largest building permit issued this year in Louisville, Ky, was taken out June 30 by Mr. A. J. Billard. He is to put up on the southwest corner of Fifth and Main Sts a four story and a half brick building.

Dr. A. M. Ross, of Toronto, has presented to Albert College, Belleville, his magnificent collection of Canadian birds, valued at $2,000. This collection is said to be the finest in the Dominion. It will be exhibited at the Paris Exposition.

The stretching across from anchorage to anchorage of the wires which are to form the great bridge cables is progressing slowly. Only the two south cables are being laid, and on an average about fifty wires a day are laid for the forming of each of the two cables. The wire contractor is not, it is alleged, furnishing wire in the quantity and at the rate called for by the contract, or the two north cables would also be in progress of construction. So far about two hundred and seventy wires have been stretched across the river, and the carrier wheels, with the pendulums hanging in front, have become familiar objects to the ferryboat passengers.

THE largest single contract ever taken in this country from a foreign nation is the $17,000,000 one given to the Providence Tool Company by the Turkish Government. The Tool Company were three years in preparing to begin the work upon the contract, and now employ 2,500 men, who turn out 200,000 guns per year, or 600 finished guns in a day. These guns are the Martini-Henry rifles. One of the side businesses of magnitude which has grown principally out of this contract is that of the Excelsior Box Company of Providence, of which James A. L. Amoreux of this city and South Hadley Falls is treasurer. The Excelsior Box Company are now busy making 20,000 boxes per year for the Tool Company in which to ship their guns to Turkey. Each box is made to hold twenty of the guns, and with such accuracy are the groove pieces for the interior of the boxes made that they do not allow a play of even one two-hundredth part of an inch of the arms, when packed with the muzzle tip and shoulder piece resting in the grooves. No other precaution is needed or used in packing the guns for shipment to Turkey. The machinery for the manufacture of these boxes was perfected in invention for the purpose. The company have still two years in which to complete the number of these boxes that they contracted to make; by which time, also, the Tool Company will have completed their immense contract with the Turkish Government.

About the first of January, 1876, Professor Hitchcock, of the Geological Survey, and his assistants began the construction of a raised map of New Hampshire, the design of which was to combine all the present knowledge of the geography of the State which has been obtained in the geological survey made by Professor Hitchcock, Professor Huntington, and others. This map has just been completed, and placed in the State House.

The map is fourteen feet ten inches long, representing one hundred and seventy-eight miles in length (being constructed on a scale of one mile to the inch) and ninety-three miles in width, from the mouth of the Piscataqua river to the north-west corner of Hinsdale, showing the entire surface of the State, nine thousand three hundred and thirty-six square miles. It also shows all the rivers, brooks, ponds, and lakes, hills and mountains, and the town and county lines, railroads, etc. The names of all cities and towns, rivers, and principle brooks, lakes and ponds, mountains and high elevations, are given conspicuously, so that any one can find at a glance what they desire to look up. The height of the hills and mountains is given on a scale of one inch to one thousand feet, and actual measurements are given when known.

The map is constructed of pine and bass wood, and the process of the work was this: A map was first drawn on paper of the same size as the raised map, with all the out-lines of towns, streams, ponds, etc., and contour lines for each five hundred feet were drawn. Tracings of the contour lines were made on inch layers of pine and bass boards, maintaining as accurately as possible the relative size and shape. These are fastened upon each other, and the valleys are beveled out with chisels.

THE new City Directory contains 149,000 names which at 3½ persons to each name gives Chicago a population of 425,000. There were 166 deaths in Chicago last week of which 22 were from scarlet-fever. During the past month 6000 dogs have been poisoned in this city, effecting an annual saving to citizens of about $150,000. There were 28 fire alarms during June, loss $26,420; insurance $24,225; total insurance involved $124,000.

RAILROAD NOTES.

The Gilman, Clinton & Springfield R. R. passed under the control of the Illinois Central R. R. July 1st.

Following the example of the Eastern railroads, the wages of all the employes of the Indianapolis and St. Louis and the Vandalia Railroads have been reduced 10 per cent. and on the St. Louis, Kansas City and Northern, 12 per cent.

The whole number of miles of railroad in existence in the year 1876, was 183,548. Of these, 74,183 miles, or nearly two-fifths, were in the United States. Great Britain and her colonies have 30,315 miles.

The sale of the New York Midland R.R., which was advertised to take place at Middletown, N.Y., June 20, has been again postponed to September 7, by Kenneth G. White, pursuant to the order of Judge Blatchford.

A contract has been closed with E Pratt Buell & Co. for the construction of the Quincy, Payson & Southeastern Narrow-guuge R. R., to run from Quincy in a southeasterly direction, through Adams county. Grading is to commence within ten days.

The Gilman Clinton & Springfield Railroad, will hereafter be known as the Springfield Division of the Illinois Central R. R. Superintendent T. J. Hudson will be retained as Division Superintendent, and no change in the present operating force will be made, at least not at present.

The old talk about the extension of the Springfield & Northwestern R. R. from Havana to Lewiston, is beingrevived. It is proposed to bridge the Illinois near Havana. This extension will open up a section of Fulton county greatly needing a railway outlet, and will give the Northwestern road direct connection with the T. P. & W. and C. B & Q. R. R. systems.

The surveying party in charge of P. J. Britton, of Grand Rapids, has completed the first line of survey for the projected narrow gauge railroad from Grand Rapids to Lansing Michigan. Mr. B. says that no insurmountable obstacles, in the way of grades and cuts, have been encountered; and that in all the villages along the line, subscriptions are being raised freely, and no difficulty will be found in procuring the right of way.

A company for the purpose of constructing a railroad from a point in the town of Freehold, in the county of Monmouth, to the town of Keyport, on the shore of the Raritan Bay, with a ferry or boat service from Keyport to some point in or near the city of New York, to be called the "Freehold and New York Railway Company," was organized in Trenton, N. J, on June 29, under the General Railroad law. The length of the road is 14 3¼ miles by rail and twenty-two miles by water, and the capital stock $200,000, divided into shares of $100 each. The following are the directors:—William H. Vredenburgh, Theodore M. Morris, Hiram B. Willetts, William R. Schultze, Samuel Osborn, John J. Schulze, Joseph B. Hoff, Telfair Hodgson, Charles M. Wiley, Herbert C. Felton, William A. Wells, Justus E. Ralph, and Samuel B. Brown.

The Michigan Central R. R. Co. last week announced the following reduction in wages: On and after July 1, 1877, a reduction of 10 per cent. will be made in the compensation of all officers and employees of every grade in the service of this Company who are now receiving over 10 cents per day, $1 per per day, or $30 per month. Where a reduction of 10 per cent. would reduce the pay of any employee below the amount above named, the pay of such shall be fixed at 10 cents per hour, $1 per day, or $30 per month, respectively, according to the present mode of computing pay. By order of the President. H. B. Ledyard, Gen'l Supt.

This is the third reduction on the Michigan Central R. R. within one year. A reduction of 10 per cent. was made about a year ago, another of 5 per cent. was ordered about two months ago, and now an additional 10 per cent. is taken off, making a total reduction in one year of 25 per cent.

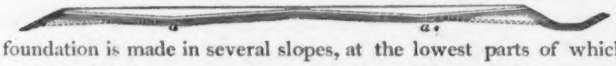
The Mount Sterling *Democrat*, speaking of the survey of the Quincy and Beardstown R. R. says: The engineers have reached Beardstown. The distance by the new line from Mount Sterling to Beardstown is twenty miles and a half—by the old survey twenty-five miles. The line is of better grade and, save one mile, will be easier worked. About one mile will be of forty feet per mile—the other nineteen miles from twenty to thirty feet per mile. The old line for eight miles and a half ran in the old bottoms of the Illinois river, requiring heavy embankments to keep above high water. The new line has less than two miles in the said river bottoms. The city council met Friday evening and appointed a committee to confer with the engineers as to the best way of passing through the city and the streets most suitable for the road to pass through. The best of feeling prevails with the council and citizens of Beardstown to aid the railway by all and every means in their power. The location is not entirely complete in Schuyler county, but it was necessary to go through to Beardstown to prove the feasibility of the new route. That having been done, we are able to announce the favorable results in the former part of the article. We hope, now that the fact is established, that we can, by this line, give our Ripley citizens the needed facilities for extending their buisness and for other great advantages that will accrue to our city, that Mount Sterling will do her duty in helping to grade this road through our county.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,
Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 169.*)

This requirement makes it impossible to have any slope on the surface (the loose material would wash away if there was any), and hence we must rely here wholly on sub-drainage, and not attempt any surface drainage. The top is made of coarse sand, *free from clay* or other binding material, laid on two and one-half to three and one-half inches thick, and spread out level. Under this is a solid foundation, about four inches thick, made of coarse gravel and clay, and having a slope of about 1:20, so that the water will run off along its top surface to either side, where it must further be disposed of by drains or ditches. In case of riding paths too wide to be so simply built, the sketch shows the method to be used. The



foundation is made in several slopes, at the lowest parts of which are placed drains, running in the direction of the path, but communicating from time to time with the sides of ditches or drains. Should, however, the ground underneath be porous enough, the drains may be dispensed with; and if in their stead holes be dug along the lowest lines, marked *a*, *a*, and these filled with large stone, the water will, through them, drain away into the ground.

Roads.—To make a good road surface is a very simple operation after it is only once understood, and, the fundamental principles thereof once comprehended, they can hardly be forgotten. Everything connected with the construction, the use and maintenance of roads, was, in times past, before the invention of railways, the subject of exact observations and experiments, many and varied in character.

Old engineering works that treat of road-making are excellent reading upon this subject at the present day. Upon road construction and no less, upon the need of better road-legislation. Some perhaps the most of the evils we suffer, in the shape of bad common roads, are merely the result, the necessary consequence of our bad systems of common road management, which are delivered from our antiquated legislation upon that subject. Legislation of this kind has changed but little in a hundred years, and is producing the same evils to-day, that it did a hundred years ago. Hence it is explainable, that the complaints concerning bad roads, and bad road management which we read in books of fifty and of sixty years ago, sound to our astonished ears as though they had been written but yesterday. On this subject may be consulted: The life of Telford, the great English road builder, who died some fifty years ago, (also among "The Lives of the Engineers," by Samuel Smiles).

Besides this, we have the results of a great number of years of experience in older countries, and there would seem to be little to invent, but much to learn, in this branch of construction. Though less progressive than other branches, there are nevertheless improvements in road-making, especially in road-making machinery and tools; and no treatise on this or any other living subject can be considered complete in a very few years after it is written.

Ancient roads were made with a surface as nearly resembling the solid rock as possible. So, in China, roads were made of huge granite-blocks laid on immovable foundations. In time these became worn with ruts, especially in the joints or seams of the stones, and the surface generally so smooth that animals could hardly stand, far less trot on it. They are now for the most part deserted, and left to be covered by land-slides, etc., to one side of the new roads of travel.

The invention of McAdam consisted in having no large stone at all on the roadway, but having it all pounded into fragments and spread over the road-bed. This has, without fear of efficient contradiction or shadow of doubt, been proved by trial to be a worthless proceeding, though at one time popular, and even now too often done, either from ignorance or laziness. The separate fragments of stone, have no bond among themselves, are liable to sink into the underlying ground or road-bed, evenly or unevenly as it may chance, more in one place than another, and thus never come to rest or to an even top surface. Between these two extremes of an ancient Chinese solid rock road and that of McAdam, lies the true principle of road-making, which consists in giving every road two component parts; one,—the foundation,—to be solid, unyielding, porous, and of large material; the other—the top surface—to be made up of lighter material, and to be made to bind compactly and evenly over the rough foundation. This constitutes the whole principle to be followed; and let it be repeated, that to dump the road material directly on the ground, without first preparing a foundation for it, as is so frequently done, is a waste of time, labor and materials, by no possibility resulting in a good road. On this one fundamental idea, which is never abandoned, however, there are a number of variations. Besides these roads, whose characteristic is the foundation they are all built on, we have paved roads, or pavements, of a great many kinds, and roads with trackways, also of various kinds.

FOUNDATION ROADS.

The roads of this kind, with macadam for the top surface, are called Telford roads by English writers, from Telford, who first built them in England. The Central Park "gravel roads" belong under this head, gravel taking the place of the macadam of the Telford roads. These foundation roads are of far greater importance than any other kind for State, county or town roads, also for parks and driveways. The top surface of all these roads must have a certain inclination, to cause efficient surface drainage. Various authorities give various rules for the amount of this inclination or side-slope. It would seem just that it should depend on the nature of the top covering, being less for more solid than for looser or softer materials, and also on the grade of the road.

In Baden, one of the smaller German States, but which is worthy to be taken as a model in matters of road-building, and in France, the rise at the centre is given as $\frac{1}{40}$-$\frac{1}{60}$ of the width of the road, according to the nature of the material; that is, inclinations of 1 in 20, and 1 in 30. The rules in Prussia prescribe inclinations of 1 in 24 for roads falling more than 4 in a hundred; 1 in 18 for roads on a grade of between 2 and 4 in a hundred; and 1 in 12 for those on a grade of less than 2 in a hundred. When first built, the centre should be made some four inches too high, to allow for after settling.

Macadam Top.—The cross-section of such a road is about as drawn;

the thickness of the foundation $b=a$, the thickness of the top covering at the centre, and in six, four or five and three and one-half inches in thickness for first, second and third class roads. If the stone for the foundation—for which most anything will do, and that kind should be taken which is cheapest to procure—happens to be got out cheapest in larger pieces than the above dimensions, it will do no harm. This foundation course is sometimes set so as to present an inclination on top, and the cover then put on of a uniform thickness over the whole breadth. This is perhaps best, but is somewhat more expensive. It will do, in nearly all cases, to set the foundation course on a level, or as near so as the stones will allow, and then make the top crowning, by making the covering say three-quarters of an inch or an inch less thick at the edges than in the centre. The stones forming the foundation should not be set in rows, nor even laid on their flat sides, but set up on edge and made to break joints as much as possible; that is, set up irregularly. After they are set up, the points that project above the general level may be broken off, and the interstices generally filled with small stone. More or less care and work are necessary in this part of the operation, according to the importance of the road and the depth and character of the material used for the top covering. To roll the road at this stage is to be recommended; afterwards it becomes a requisite. The point never to be lost sight of, is that this foundation course must remain porous, must be *pervious* to water, so that all rain-water that shall soak through the top covering will find, through it, means of escape to the ground underneath; thence,

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

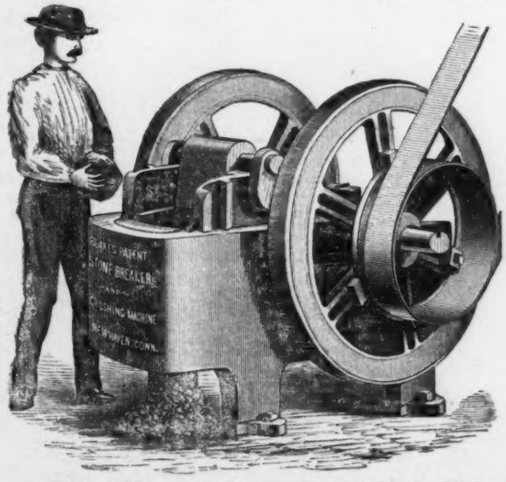
according to the nature of the subsoil, it is left either to soak into the ground, or must be further led away by appropriate drains.

Of very great importance is the *material* used for the top or road covering. In the order of their value for macadam, we have.

I. Basalt.
II. Syenite and Granite.
III. Limestones.
IV. Sandstones.

It will be evident, that a much greater quantity of the soft stones would be required to repair a certain road, than of a harder kind, and on a road lying out of the way of a hard stone quarry or deposit, the question will arise which is cheapest, to pay more for the raw material and get good stock, or pay less and use the worse? There has been some interesting results in places where this matter has been the subject of experiment, continued for a number of years. Thus, on a road in Baden which was formerly macadamized with rock costing only fifty cents per cubic yard, it was finally found cheaper, to take harder rock from a distance costing one dollar and seventy-eight cents per cubic yard, the saving being both in less *quantity* of material used and less *labor* required in repairs. Just where the limit is, must be found in each case by long continued experiment, which is well worth the trouble to make, both to save expense and also to have the best possible road, the harder material making a road better at all times, at the same or less cost. After the right kind has been determined, none other should be mixed with it, and should any inferior piece accidentally or designedly get into the stock to be broken up, it should be picked out and thrown aside. The stone is broken up into macadam, either by hand or machinery. Whenever any considerable quantity of macadam is in present or future demand, a stone-breaker is certainly a saving over hand-labor, though it is difficult to draw a line exactly, where hand-labor or machine labor is cheapest. Probably no town that pretends to keep thirty or forty miles of road in good repair, ought to be without one of these labor-

Fig. 5. Perspective View of New Pattern Crusher.



saving machines. Those most in use are made by the Blake Crusher Co., of New Haven, Conn., and the following is taken from their circular.

Their machine has been patented in the United States and in several foreign countries, and is now in use in almost every country on the globe. It is simple and compact, and being complete in itself, requires no extraneous support or fixtures. Two patterns of the machine are now sold: the old, or "Lever Pattern," and the new, or "Eccentric Pattern." The figures, and following description, refer to the last named machine. Fig. 5, is a perspective view of the machine, entire. The frame which receives and supports all the other parts, is cast in one piece, with feet to stand on the floor or on timbers. These feet are provided with holes for bolts, by which it may be fastened down if desired; but this is unnecessary, as its own weight gives it all the stability it requires. The flywheels are on a shaft which has its bearings on the frame, and which between these bearings, is formed into a short crank. On the same shaft is a pulley, to receive a belt from a steam-engine or other driver.

Fig. 6. Sectional View of New Pattern Crusher, with Parts Lettered for Convenience in Designating Pieces Wanted for Repairs.

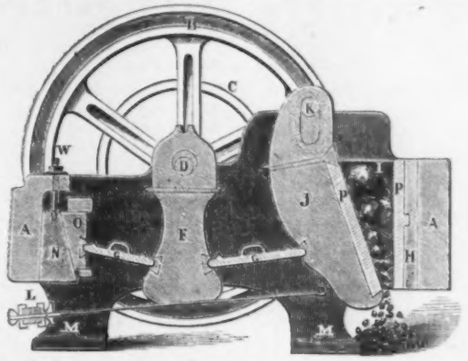


Figure 6 shows a side view or elevation of the other parts in the machine in place as they are presented to view through the side of the frame. The circle D, is a section of the fly-wheel shaft, which should make from 225 to 250 revolutions per minute. The circle around D is a section of the eccentric. F is a pitman or connecting rod, which connects the eccentric with the toggles G, G, which have their bearings, forming an elbow or toggle joint. H, is the fixed jaw; this is bedded in zinc against the ends of the frame ¼ inch thick. P, P, are chilled plates against which the stone is crushed; when worn at the lower end they can be inverted, and thus present a new wearing surface. The cheeks I, I, fit in recesses on each side, and hold the plates in place; by changing the position of the cheeks from right to left, when worn, both will have a new surface. J, is the movable jaw; this is supported round the bar of iron K, which passes freely through it, and forms the pivot upon which it vibrates. L, is a spring of India rubber, which is compressed by the forward movement of the jaw, and aids its return. M, M, are bolt holes. B, is the fly wheel. C, is the driving pulley. Every revolution of the crank causes the lower end of the movable jaw to advance towards the fixed jaw about one-fourth of an inch and return. Hence, if a stone be dropped in between the convergent faces of the jaws, it will be broken by the next succeeding bite; the resulting fragments will then fall lower down and be broken again, and so on until they are made small enough to pass out at the bottom. The readiness with which the hardest stones yield at once to the influence of this gentle and quiet movement, and melt down into small fragments, surprises and astonishes every one who witnesses the operation of the machine.

It will be seen that the distance between the jaws at the bottom limits the size of the fragments This distance, and consequently the size of the fragments, may be regulated at pleasure. A variation to the extent of ⅛ths of an inch may be made by turning the screw-nut W, which raises or lowers the wedge N, and moves the toggle-block O forward or back. Further variations may be made by substituting for the toggles G, G, or either of them, others that are longer or shorter; extra toggles of different lengths being furnished for this purpose.

This machine may be made of any size. The builders have patterns for some 13 different sizes on hand at the present day. Each size will break any stone, one end of which can be entered into the opening between the jaws at the top. The size of the machine is designed by the size of this opening; thus, if the width of the jaws be ten inches, and the distance between them at the top five inches, we call the size 10×5. The following table shows the principle facts that relate to the sizes of machines that are used, generally, for the making of road-metal.

No.	SIZE, or receiving capacity.	Product per hour in cubic yards. (See Note.)	Weight of Heaviest Piece.	Total Weight.	Extreme Dimensions.			Driving Pulley.		Proper Speed.	Horse power required.	Cash Price Delivered on board May, 1877.
					Length	Bre'dth	Height.	Diam.	Face.			
	Inches.				ft. in.	ft. in.	ft. in.	ft. in.	inch.			
2	10×7	Five.	4339	8000	5 3½	3 8	4 5	2 0	7½	250	6	$900
*3	15×5	Six.	4700	9100	8 7	5 0	5 0	2 4	8	180	9	1035
*4	15×7	Six.	5890	10490	8 7	5 0	5 0	2 4	9	180	9	1125
5	15×9	Seven.	6436	13360	6 5	5 0	5 11	2 6	9	250	9	1234

Note.—The amount of *product* depends on the distance the jaws are set apart, and th speed. The product given in the Table is due when the jaws are set 1 1-2 inches open at the bottom, and the machine is run at its *proper speed* and *diligently fed*. But it will also vary somewhat with the character of the stone. Hard stone or ore that breaks with a snap will go through faster than Sand stone.

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 170.*)

PARABOLIC RIB, FIXED AT ENDS. TABLE FOR M. $M = s\,c\,W$. VALUES OF s.

Point of Division.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
W on 1	−.0789	+.0171	+.0135	+.0102	+.0073	+.0047	+.0025	+.0005	−.0010	−.0023	−.0031	−.0037	−.0039	−.0038	−.0033	−.0025	−.0014	−.0001	+.0010	+.0020	+.0065
" 2	−.1214	+.0358	+.0510	+.0391	+.0254	+.0189	+.0106	+.0030	−.0022	−.0069	−.0103	−.0124	−.0134	−.0132	−.0117	−.0091	−.0052	−.0001	+.0062	+.0137	+.0225
" 3	−.1354	+.0647	+.0885	+.0541	+.0422	+.0427	+.0256	+.0110	−.0011	−.0109	−.0152	−.0180	−.0179	−.0157	−.0107	−.0052	−.0001	+.0052	+.0113	+.0259	+.0430
" 4	−.1280	+.0749	+.1075	+.0629	+.0633	+.0760	+.0484	+.0245	+.0045	−.0116	−.0239	−.0324	−.0371	−.0379	−.0348	−.0280	−.0173	−.0027	+.0085	+.0259	+.0640
" 5	−.1054	+.0712	+.1316	+.0739	+.0793	+.1186	+.0793	+.0452	+.0164	−.0071	−.0254	−.0324	−.0384	−.0379	−.0348	−.0280	−.0173	−.0027	+.0085	+.0259	+.0640
" 6	−.0734	+.0579	+.1357	+.0769	+.1191	+.1705	+.1191	+.0744	+.0303	−.0047	−.0202	−.0285	−.0324	−.0379	−.0435	−.0457	−.0376	−.0242	−.0183	−.0534	−.0946
" 7	−.0369	+.0388	+.1330	+.0194	+.0284	+.0311	+.0679	+.1126	+.0650	+.0252	−.0069	−.0313	−.0478	−.0566	−.0557	−.0509	−.0363	−.0188	−.0103	−.0490	−.0959
" 8	0	+.0173	+.0259	+.0359	+.0173	0	+.0259	+.0605	+.1037	+.0555	+.0160	−.0149	−.0372	−.0508	−.0557	−.0521	−.0404	−.0232	−.0160	−.0388	−.0836
" 9	−.0340	+.0234	+.0165	+.0280	+.0375	+.0390	+.0313	+.0179	+.0524	+.0965	+.0494	+.0434	+.0174	+.0370	+.0473	+.0485	+.0390	+.0234	+.0062	+.0234	+.0625
" 10	−.0625	+.0234	+.0062	+.0266	+.0404	+.0485	+.0473	+.0370	+.0174	+.0114	+.0494	+.0695	+.0524	+.0179	+.0313	+.0231	+.0390	+.0234	+.0062	+.0165	+.0404
" 11	−.0856	+.0388	+.0312	+.0232	+.0397	+.0485	+.0557	+.0509	+.0372	+.0149	+.0160	+.0555	+.1037	+.0566	+.0473	+.0313	+.0174	+.0059	+.0280	+.0259	+.0173
" 12	−.0959	+.0400	+.0538	+.0188	+.0397	+.0541	+.0576	+.0566	+.0478	+.0313	+.0252	+.0652	+.1037	+.0605	+.0559	+.0455	+.0194	+.0069	+.0357	+.0388	+.0259
" 13	−.0994	+.0538	+.0534	+.0141	+.0383	+.0509	+.0537	+.0560	+.0508	+.0372	+.0202	+.0363	+.0650	+.1126	+.0679	+.0311	+.0019	−.0188	−.0357	−.0579	−.0734
" 14	−.0946	+.0534	+.0411	+.0093	+.0307	+.0455	+.0537	+.0552	+.0457	+.0149	+.0069	+.0252	+.0363	+.0744	+.1191	+.0705	+.0284	−.0069	−.0316	−.0712	−.1054
" 15	−.0820	+.0478	+.0183	+.0056	+.0242	+.0376	+.0457	+.0455	+.0313	+.0252	+.0160	+.0311	+.0478	+.0793	+.1186	+.0760	+.0632	−.0132	−.0429	−.0749	−.1280
" 16	−.0640	+.0370	+.0157	+.0027	+.0173	+.0280	+.0348	+.0379	+.0371	+.0324	+.0202	+.0363	+.0508	+.0452	+.0434	+.0427	+.0284	−.0075	−.0341	−.0647	−.1054
" 17	−.0430	+.0259	+.0113	+.0009	+.0107	+.0180	+.0229	+.0254	+.0230	+.0239	+.0160	+.0252	+.0372	+.0215	+.0256	+.0189	+.0106	+.0284	−.0085	−.0358	−.0314
" 18	−.0225	+.0137	+.0062	+.0001	+.0052	+.0091	+.0117	+.0132	+.0152	+.0103	+.0069	+.0103	+.0132	+.0036	+.0106	+.0189	+.0284	+.0391	+.0510	+.0358	−.0171
" 19	−.0065	+.0040	+.0019	−.0001	−.0014	−.0025	−.0033	−.0035	−.0039	−.0037	−.0031	−.0023	−.0010	+.0005	+.0025	+.0047	+.0073	+.0102	+.0135	+.0171	+.0789

$P_2 = 12 - 7.284 = 4.716$ tons. $\quad H = 4.575 \times 2.5 = 11.44$ tons.

Since $H y_1$ = moment at the springing A, Fig. 15; since each of these loads has a separate H and a definite y_1; and since the H's for the different loads all conspire to produce the total thrust, we must calculate the arm with which the latter acts at one or both springings, that is the ordinate y_1' or y_2' of the point where the curve of equilibrium must begin. We satisfy the equation

$$y_1' \cdot \Sigma H = \Sigma H \cdot y_1, \text{ or } y_1' = \frac{\Sigma H \cdot y_1}{\Sigma H},$$

which simply requires that the resultant moment shall be equal to the algebraic sum of the original moments. We therefore multiply each H for a given weight by its y_1, and divide the sum of the products by the gross H. The calculation having been made, as here set down, we find that y_1' is equal to −.02 ft., a comparatively insignificant amount. It is well to compute y_2'' also, as a check on the accuracy of the subsequent drawing, and it will be found to be + 3.34 ft.

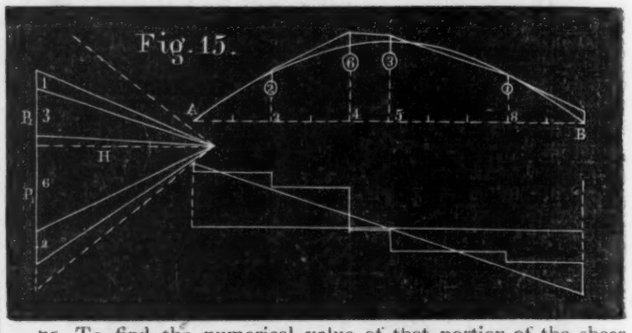
y_1	H	M
−.667 ×	0.384 =	−0.256 c tons
0 ×	2.592 =	0
+.133 ×	1.407 =	+0.188 "
+.333 ×	0.192 =	+0.064 "
4.275 |		−0.004 "

$$-0.00\,9\,\frac{k}{20}$$

$y_1' = -0.018$ ft.

While we may seem to have carried out this example in too much detail, we are aware how inattention to apparently trivial points will sometimes cause trouble, and we have therefore given most of the work at full length. If we now lay off the weights in order on the load line, plot the two vertical components, P_1 and P_2, of the reactions, and finally lay off H, as just computed, placing these external forces in the proper order to make a close polygon as one passes round the figure, we have only to draw radiating lines from the extremity of H, to the points of division on the load line, to complete the stress diagram. Now start above or below A, a distance y_1' (in this case below, since y_1' is minus), and draw the funicular polygon with sides parallel to the inclined lines of the stress diagram, checking the resulting curve of equilibrium by the fact that it strikes the extremity of the calculated ordinate y_1'. Fig. 15 illustrates this case. The diagram for shear is also shown below and needs no explanation, as the construction is similar to previous cases. It is, however, drawn to a less scale than the stress diagram, to save room. The dotted lines in the stress diagram determine the values of V. It is quite noticeable in this figure how the shear changes sign wherever the bending moment becomes a maximum.

Fig. 15.



75. To find the numerical value of that portion of the shear which is resisted by the braces of an arch with fixed ends we proceed as we did in the case of an arch with hinged ends. The values of P_1, the vertical component of the abutment reaction at the left, have been found. We then need only calculate the value of $V_1 = 2\,\frac{k}{c}\,H$ and form a table, as was done in § 58. It is probably not necessary to repeat the operations at length here. A table of shears for an arch with fixed ends, and for twenty divisions, has been prepared, the shears applying to the middle of the divisions, and is given below. The same remarks apply to it as to the previous similar table for the parabolic arch with hinged ends.

76. A diagram is also presented, Fig. 16, showing, by the full lines, the loads required to produce the maximum + M, from live load, at the point whose number is attached to the line, and by the remaining blank portion, the load required for maximum — M at the same point. The broken lines and the blank portion in each *space* represent the way of distributing the load for maximum + F and — F respectively. It is still more apparent from this figure than from Fig. 13, that any investigation which considers the rolling load as continuous from one abutment a certain distance over a portion of the span will not determine actual maximum stresses.

A comparison of Fig. 16 with Fig. 13 will not be uninstructive, as showing the different loading when hinges are omitted, to produce maxima bending moments and shears. There are four points near the ends of rib with fixed ends which require that loads should be on both ends of the span at once, to produce the maximum + M at those points; and five points at the middle which have the maximum — M under similar circumstances. In some structures such conditions can be realized. If we foot up the plus and minus values of the columns in the tables for M and F, we shall readily see that, with the exception of the springing points, all the points of division in the arch with fixed ends have *less* maxima bending moments of either kind, for a load W at each loaded joint, than in the case of the arch with hinged ends, and, in most cases, the values are materially less. A similar comparison of maxima shears will show that the arch with fixed ends has to carry more shear over its web

(*To be continued.*)

NEW WATER WORKS OF DETROIT, MICH.

Taking advantage of a recent detention of a few hours in Detroit, Mich., we made a brief visit to the new waterworks, for further supplying that city, which are now rapidly approaching completion. These works are situated some four miles from the centre of the city, in the suburb known as Hamtramck, where the Detroit river flows from Lake St. Clair. The pumping engine was designed and built at the Detroit Locomotive Works. It is arranged as follows: A large conical hollow standard of cast iron, which forms the air vessel, carries on its upper end a walking beam, near one end of which is attached the connecting and piston rod of a vertical, high pressure steam cylinder, while at the other end, is connected the piston of the low pressure cylinder, the engine being compound. From the extremity of the beam next to the high pressure cylinder the fly wheel is driven. Immediately below each of the steam cylinders is a pump cylinder double acting, with piston, taking water directly from the pits or wells in which they are situated. The passages and connections are very short and direct, so that we should look for good results. Both pumps discharge into the air vessel between them through a great number of valves, and the water is thence carried to a stand pipe by which the desired pressure on the main is secured.

The water is taken from the river through a large inlet pipe of iron which extends in a dredged trench several hundred feet from the shore to about fifteen feet of water. It was laid in sections and bolted together by a diver. The water then flows into a large, receiving basin, which was made partly by dredging and partly by enclosing the area with a double row of sheet piling, filled in with clay; the depth of water is about fifteen feet. A timber bulkhead within the basin, extending nearly across the lower end, is intended to check any current from the flow through the inlet pipe. This reservior will act as a settling basin, if necessary, although we think that it will seldom be needed for this purpose, and will serve as a source of temporary supply in case of trouble from anchor ice. A square brick shaft at each end of the basin contains valves for shutting both the inlet pipe and the conduit to the pumps. This conduit is of brick, 5 feet in diameter, and leads to a well, 16 feet in diameter, whence a branch leads to each of two pump pits, only one of which is at present occupied, by the engine described above.

The pit is 26 feet deep, the pump cylinders being supported on its bottom, and the bearings of the walking beam are some thirty feet above the floor of the engine room. The high pressure steam cylinder is 44″ in diameter, the low pressure one is 84″ in diameter, the two pump cylinders are 40″ diameter, and the stroke of all is six feet. The air chamber, a truncated cone, has a diameter of ten feet at the bottom and about seven feet at the top, and is made of cast iron, in segments bolted together through flanges, inside in the upper part, outside below. The eduction valves of the pumps are all grouped in four rings, around the inside circumference of this air vessel, each tier containing 58 valves, 7 inches in diameter, faced with rubber, rising and falling vertically and held in place by spiral springs. By a man-hole and interior iron ladder access can be had, when desired, to the interior of the air vessel and to these valves. The induction valves are flaps of iron, faced with leather. The pistons of both steam and pump cylinders have metallic packing rings. The walking beam is an excellent one, made of six steel plates, three on each side, with cast iron filling pieces, reamed holes and turned rivets. It is light and very strong. The fly wheel is 24 feet diameter and weighs 30 tons.

The high pressure cylinder is nearest to, and but a short distance from, the boilers, and the exhaust steam from this cylinder then passes directly across one side of the frame to the other cylinder. The condenser is placed a little on one side and is worked by a small independent engine. The steam cylinders and the exhaust pipe from one to the other will be steam jacketed, and the cylinders will be lagged with black walnut. There are four double furnaces with eight cylindrical boilers, 8 feet in diameter, containing flues below and tubes above. The chimney is octagonal, 136 feet high, with a flue of circular section, 5 feet in diameter.

The stand pipe, of wrought iron, situated near, and on the same line with, the engine house, is 127 feet high, 4½ feet in diameter at the bottom, and 2½ feet at the top. The enclosing building having a stone lower story, a brick tower, and a wooden roof will be 180 feet high. This building was designed by J. E. Sparks, Architect, of Detroit.

The pumping house is a handsome, fire-proof structure of brick with sandstone trimmings and iron cornice, the roof being made with iron trusses, from the Detroit Bridge and Iron Company, covered with slates fastened to iron purlins by copper wire. It contains a second pit, ready for another pumping engine when needed; a second boiler house and chimney are also completed.

All of the heavy machinery was placed in position with ease by means of a temporary overhead traveller, and two winches with wire ropes.

The works have been erected under the supervision of D. Farrand Henry, C. E., the engineer of the Water Commissioners.

SAN ANTONIO, Texas, having been aroused to new life and activity by the completion of a railroad connecting her with the outside world, is about to add a system of water works to her attractions, the works to be completed by July, 1878.

JOHN KENNEDY, C. E., Engineer of the Harbor Board of Montreal, having reported in favor of the building of the Craig street sewer in that city, the Council have voted to proceed with the work at once. The cost of the tunnel will be $80,000.

THE Third Avenue Railroad Company, of New York City, is about to avail itself of the permission to put steam motors upon its lines, by trying them between the upper end of Harlem and Sixty-fifth street, a distance of three and one quarter miles. Five motors will at once be put on, and more will be added if the trials are satisfactory.

THE New York Central and Hudson River Railroad Company have received permission, from the common council of New York, to lay iron pipes, for conveying oil, in 65th, street, from 11th Ave., to the East River, and across the river and Blackwell's Island to the Long Island shore, to connect with the oil works of the Standard Oil Company.

AT a meeting of the New York and Brooklyn Bridge Company, held July 2, a report of the executive committee was adopted, favoring an increase in size of the wires for the great cables. It was stated that the same machinery could be used as for the smaller size, and that there would be no diminution in the elasticity or tensile strength of the wire. The total expenditures, to June 30, have been $7,547,135.52 with present additional liabilities of $31,000.

THE JAPAN LIGHTS.*

BY RICHARD HENRY BRUNTON, M. INST. C. E.

The Government of Japan, in entering into friendly relations with foreign powers, stipulated that certain ports were to be open, and that mercantile operations were to be confined to those places. These ports are:

1. Hakodate in the island of Yezo.

2. Yokohama, 20 miles from the northern capital of the country, Yedo, or Tokio.

3. Kobe, 50 miles from the southern capital, Kioto, and near the entrance to the Inland sea.

4. Ozaka, between Kobe and Kioto, being twenty miles from the former.

5. Nagasaki, in the southwest portion of the island of Kiusiu.

6. Niigata, on the west coast of the Main Island.

The principal trade is at Yokohama, where from two hundred to three hundred foreign-owned vessels of large size annually resort. The next places in importance are Kobe and Nagasaki, at each of which about one hundred and seventy vessels arrive every year. Hakodate is in a high latitude, and its trade is almost entirely confined to the summer months, but it is at no time of any great extent. Niigata and Ozaka are visited by few ships. All these ports, however, are the rendezvous for a considerable native trade, which is every year increasing.

The foreign powers arranged, and it forms one of the clauses in the existing treaties, that the Japanese Government should "provide the treaty ports with such lights as may be necessary to render secure navigation of the approaches to said ports." On the 17th of November, 1866, Sir Harry S. Parkes, K. C. B., H. B. M. representative, directed the attention of the Japanese Government to the existence of this stipulation, and requested that steps might be taken to carry out its purport.

The French and American ministers shortly afterward made similar representations, and a favorable reply was received from the Japanese ministers early in December of the same year. Sir H. S. Parkes had previously received suggestions from naval officers and others relative to the most important sites for the lights, and these he laid before the Japanese Government. The erection of eleven lights was agreed to, and Sir H. S. Parkes was requested to use his influence with Her Majesty's Government, in order that the necessary apparatus and the assistance required to establish lighthouses might be obtained. The matter having been refered to the Board of Trade, that department consulted the Trinity House, and eventually, on the 6th of November, 1867, Messrs. D. and T. Stevenson, MM. Inst. C. E., the Engineers to the Commissioners of Northern Lights, were desired to select suitable persons to undertake the design and construction of the lighthouses, and to introduce the lighthouse service into Japan. The Board of Trade had the general management and supervision of the arrangements, while the Messrs. Stevenson, who pointed out the difficulties likely to be experienced from the constant recurrence of earthquake shocks in Japan, had charge of the construction of the apparatus for six of the lights which had been ordered.

The author received the appointment of Chief Engineer in February, 1868, and he arrived in Japan in August of the same year.

Out of more than twenty-five sites suggested by those to whom the matter had been referred in Japan, five points appeared to be generally concurred in. These were:—A second order revolving light at Oshima (Kashinosaki); a first order fixed light at Shiwomisaki; a first order fixed light at Iwoshima; a first order fixed light at Satanomisaki; and a lightship at Hakodate.

It was found, however, impossible to select from the various suggestions the most advantageous positions for the remaining six lights authorized by the Japanese Government. A proposal was therefore made by Sir H. S. Parkes to complete the necessary information by a mixed Commission of the senior naval officers of England, France, and America then in Japan, the Japanese Government being also represented on it. This Commission consisted of Captain Hewett, of the English navy; Commodore Goldsborough, of the United States navy; and Commandant Amet, of the French navy. The Japanese war-steamer "Fujiyama" was placed at the disposal of these officers, and they visited the various points in November 1867. They agreed in recommending a first order fixed light on Noshima; a first order fixed light on Mikomoto (Rock Island); a second order flashing light on Tsurugisaki (Sagami); a third order fixed light on Kannonsaki; a red floating light at Yokohama harbor; as well as several buoys and beacons in the Gulf of Yedo.

Some time previous to the formation of this Commission the apparatus of several lights had been ordered from France through a staff of French engineers, who were then engaged in forming an arsenal at Yokoska, on the west coast of the Gulf of Yedo, about ten miles from Yokohama. These were intended to light the approaches to the arsenal; but the Commission recommended that they should be placed on those points most urgently requiring illumination. It was afterwards found that the only spots suitable for them in the Gulf of Yedo were Noshima and Kannonsaki. The first order fixed apparatus from France was accordingly placed at Noshima, and the third fixed apparatus at Kannonsaki, and these two lighthouses were erected under the superintendence of the French engineers above mentioned.

On arriving in Japan, the author examined the sites of the lighthouses which had been decided on; and, as

* Paper read before the Institution of Civil Engineers, London.

they were spread over 1,500 miles of coast, and there were no means of internal communication, Admiral Sir Henry Keppel, then on the Japan station, was induced to grant the use of H.M.S "Manilla" for a voyage of inspection. In addition to collecting information and taking the requisite observations in regard to those points already decided on, the author received instructions to inspect and report upon the best method of lighting the Inland Sea and the approaches to Kobe and Ozaka; for which purpose the Japanese Government, in the beginning of 1867, had authorized the apparatus for five additional lights. The Inland Sea, separating the main line from Kiusiu and Shikoku, is about 250 miles long, and, at some places, it is 50 miles wide; it is filled with several thousand small islands, and navigation is carried on through recognized channels between them. It may be judged, therefore, that to place a light on every point in the Inland Sea requisite to render navigation through it practicable, on dark nights, would be a work of magnitude and of doubtful utility. On the other hand a few lights might be so placed that, with their assistance, a considerable portion of the sea would be navigable at night, and vessels would be guided to places where they might anchor with safety and wait for daylight.

The proposals made by the author were based on the following principles. 1st. To put no light where the headlands are bold and well defined, or where no hidden dangers exist. 2nd. Where there are difficult and dangerous channels, through which vessels could not proceed in dark weather, to place lights to lead them into a safe anchorage where they can wait for daylight; and, if possible, in such a position that advantage may be taken of them of going through the channel. 3rd. Where a light would render a channel easy to pass through, which, without it, would be difficult, or where a light is likely to be required to give mariners a clue to their position, regarding which they may, at night, get easily confused among the numerous islands, a light should be placed.

Having regard to these considerations, the author fixed upon the following points at the approaches to Kobe, and Ozaka, and in the Inland Sea, as being the most advantageous:—A third order fixed light at Tomagaishima; a fourth order fixed light at Temposan (Ozaka); a fourth order fixed light (red) at Wadanomisaki (Dobe); a first fixed order light at Yesaki (Awaji); a fourth order fixed light at Nabeshima; a third order fixed light at Tsurishima; a third order fixed light at Hesaki; and a fourth order fixed light at Rockuren. These proposals were laid before various nautical authorities. They received general approval, and the erection of the lighthouses was ultimately authorized.

Soon after the completion of two or three lighthouses, the Government showed its appreciation of them by deciding that the old system of wood fires should be abolished, and that properly illuminated lighthouses should take their place. A notification was issued by the Council of State calling upon the local authorities to name the places at which local lights were needed, and instructing them that the old system of wood fires must be discontinued. The result of this notification is that many applications for small lights have been received from all parts of the country. But as the Imperial Government has, except in a few important cases, refused to bear the expense of these lights, and as the local governments are generally unable to do so, not many of the proposals have as yet been carried out. Eleven such lights are now established, and from ten to fifteen others are under consideration.

Those which have been completed are:—A staff light on the pier in Yokohama harbor; a fifth order fixed light at Shinagawa in Yedo Harbor;* a fifth order fixed light at Jokashima, near the entrance to the Gulf of Yedo;* a sixth order fixed red light at Irosaki, near Mikomoto (Rock Island); a fourth order fixed light at Sugashima, the entrance to Toba harbor; a fourth order revolving light at the entrance to Matoya harbor; a fourth order red fixed light at Shirasu, west of Shimonoseki Straits; a staff light on Noshiaf, the eastmost point of the island of Yezo; a staff light in Nemuro harbor, in Yezo; a staff light at Awomori harbor; and a staff light at Ishi-no-maki, at the mouth of the river Kita-kami.

The Government, desirous of further perfecting the illumination of the coast, decided on erecting several ocean lights on those points most in need of illumination. These are in addition to the lights already specified, which was demanded by the treaty powers. A full and complete scheme for the illumination of the entire coast was drawn up, and those sites which were considered most important were first dealt with. Seven of these lighthouses are completed, and the positions for thirty others have been visited, examined, and reported on. Before finally deciding to erect any lighthouse, the author submitted his proposals to the naval authorities in Japan at the time, and to many captains of vessels trading on the coast. Captain St. John, of H.M. surveying ship "Sylvia," gave especial attention to the matter, and rendered great assistance by his advice.

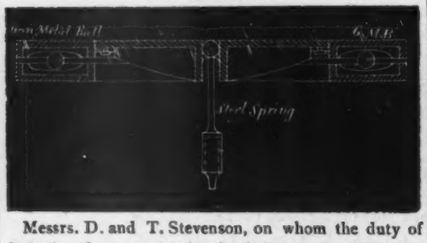
These seven lights are situated as follows:—A second order fixed light at Siriyasaki, the north-easternmost point of the main island; a first order revolving light at Kinkasan, east coast, north of Yokohama; a first order revolving light at Inuboyesaki, east coast, north of Yokohama; a first order revolving light at Omaesaki, south coast; a first order flashing light at Kadoshima, west coast, north of Shimonoseki; a second order fixed light at Yebosishima, west coast, south of Shimonoseki; and a fourth order fixed light at Haneda Gulf of Yedo.

The apparatus of these lights, as well as for the harbor lights already mentioned, was ordered, without the intervention of the Board of Trade, through Messrs. D. and T. Stevenson, who, in September, 1871, were appointed Consulting Engineers to the Japanese Lighthouse Department.

A complete list of the lighthouses, lightships, buoys and beacons established by the author on the coast of Japan will be found in the Appendix.

In designing the lighthouses the most important point for consideration was the liability of the country to the periodical recurrence of earthquakes. No definite records had been kept of these disturbances, nor could data be procured as to the localities most subject to them. It is well known, however, that slight shocks are of frequent occurrence, and that, during the present century, fifteen shocks of a destructive character have been experienced. These were felt in different parts of the country, the northern capital, Yedo, being most subject to them, where five out of the fifteen occurred, the remaining ten being pretty equally distributed. The palace of the Emperor at Kioto was destroyed by an earthquake in 1828, as well as most of the temples with which that city abounded. In 1846, in the province of Shinano, on the west coast, the earth swallowed up eighteen houses, five thousand dwellings being at the same time destroyed. The most recent destructive earthquake, in the year 1855, was chiefly felt at Yedo, when the trembling earth continued for one month, and eighty severe shocks occurred; about one hundred and twenty thousand lives were supposed to be lost on this occasion.

ASEISMATIC JOINT.



Messrs. D. and T. Stevenson, on whom the duty of designing the apparatus for the lights devolved, deemed it necessary to "take some steps so secure these from derangement, and the lamps from partial or total extinction on the occurrence of the many modified shocks which visit the country." The arrangements carried out have been thus prescribed by Mr. David Stevenson:—"It is evident that any sudden lateral motion of the earth, on which a building rests, must be communicated to the foundation of the structure, and thence through all the rigid and unyielding materials of which it is composed to its very summit, where the violence of the shock will be aggravated by the greater elevation of the highest point of the building above the source of motion. On fully considering this action of earthquakes, it seemed to me that what was required to neutralize their shocks was a *break* in the continuity of the rigid parts forming the structure, so as to prevent the propagation of the shock. . . . . The plan I proposed for this purpose, which may, for brevity, be termed an *aseismatic joint*, is the introduction of spherical balls of ball metal, working in cups of the same material, placed between two platforms, the lower cups being fixed to beams forming the foundation, and the upper cups being fixed to the lower beams of the superstructure, thus admitting, within a limited range, free motion of the upper over the lower part of the building." The Board of Trade sanctioned this arrangement for the lights first ordered, the apparatus for these being now placed on tables having an aseismatic joint on the principle described.

The Author's experience of the contrivance is not altogether favorable. He finds that, while the free motion of the upper over the lower part of a structure may neutralize the effects of an earthquake shock, such free motion will, at other times, occasion inconvenient results. Thus, were such a joint placed above the foundations of a lighthouse tower, the pressure exerted by a gale of wind on the superstructure would give rise to a motion probably equally as distressing as a severe earthquake. In the same way a person stepping on one of aseismatic tables, for the purpose of trimming or cleaning the lamps, causes the upper part to roll to such an extent that the lamps become deranged, and in the case of revolving lights the regular motion of the clock-work machinery is destroyed.

Messrs. Stevenson introduced a stout spring in a vertical position, the lower part of which was securely fixed, while the upper part was attached to a ball working in a socket in the centre of the upper table. This was intended to regulate the movement, but it was only partially successful. The problem is to form a joint sufficiently sensitive to move freely on the occasion of an earthquake, but so stiff that no inconvenient motion will be occasioned by ordinary disturbances. Messrs. Stevenson's design was, for the reasons named, not adopted in any of the other lighthouses.

From the observations of those who have examined the effects of earthquakes, and have given their attention to the subject, it may be accepted that there is a double motion in all shocks, the first movement tending to overthrow, while the second tends to restore the equilibrium. If, therefore, a building could be constructed with sufficient power of resilience, its overthrow or destruction could not occur so long as the oscillation caused by the earthquake did not go beyond its limit of equilibrium. This seems to have been the leading principle in the native architecture of the country. The houses are constructed with a light wooden framework, without diagonal struts or ties of any kind. The roofs are heavy, and the uprights which support them are mortised into horizontal beams at the top and at the bottom. The buildings are evidently designed to have a maximum of elasticity, and they can, no doubt, be, and often are, moved off the vertical to a great extent without fracture. Their efficacy in resisting severe earthquakes, however, is questionable. The system further seemed open to the objection of excessive weakness, and consequent inability to withstand the other disturbing forces to which a building is exposed. The only alternative method that seemed feasible was to give the lighthouses great weight and solidity, thereby adding to their inertia and checking their oscillation. It has been laid down by Professor Palmieri, of Naples, probably the most experienced earthquake observer in the world, that although solidity and strength in a building do not afford perfect protection against an earthquake, still so long as fracture does not occur, absolute overthrow is almost impossible. This principle of solidity combined with strength was the one adopted by the Author in designing the lighthouses, and in carrying out the different details of their construction.

(To be continued)

* These lights were erected by the Yokoska officials.

VENTILATION OF SEWERS.

Written for "Engineering News."

In the many recent articles in your valuable paper on the subject of sewers and sewerage, it seems to me the question of ventilation has not received the attention its importance deserves. Many of our cities possessing, otherwise, excellent systems of sewerage, have neglected the subject entirely; while others have as systematic, or

effective means to secure the object. It is a question who are most responsible for the resultant evils, Physicians, Engineers, or local authorities, who are too often unmindfull of recommendations made to them, unless the facts are a patent as to require no theoretical deductions. The Physician fulfills his duty when he puts on record the cases under his observation which can be traced to defects in the sewer; it then devolves on the Engineer to suggest means to eliminate the evils existing from faulty construction; and the local authorities are surely reprehensible, after the facts are brought to their attention, if the recommendations are not acted upon. The evils from pollution of the subsoil from permeable sewers have lately been referred to in your columns, and every Hydraulic Engineer is aware of the importances of constructing sewers so as to be impervious, yet I am aware of brick sewers having been built within the past few years, in one of the most populous cities in New England, with *dry inverts*, to avoid the expenses of properly dealing with water in the excavations, thus forming elongated cess-pools in the midst of the city. The same city has no means whatever for ventilating its sewers, which are of an aggregate length of between 30 and 40 miles, although the need of something being done was called to the attention of its city council a few months since, with the concurrent testimony of many of its leading resident physicians. Unfortunately the Board of Health, in the city referred to, is composed of members of the council, who are totally unmindful or ignorant of the need of action in the premises. The subject is not a novel one. Dr. Geo. Derby, of Boston, in a paper published in the *Medical and Surgical Journal*, in Feb., 1873, says, regarding sewer gas: "Whatever gases are contained in these underground passages, seek not only to diffuse themselves under the law of nature, with regard to gaseous bodies, but are also frequently subjected to severe pressure. These gases are dangerous to health. What the specially noxious element in them is, no one can define. It is evidently neither carbonic acid nor sulphuretted hydrogen, nor any other of the gases with which chemists are familiar in the laboratory. There is something beyond all this, coming from the decay of organized substances in a closed pent-up position, without the free access of light and air, which at times give rise to the most virulent poison, and to the most destructive forms of disease.

"The sensible properties of sewer gas are quite remarkable. It is by no means fœtid, as many people suppose, neither is it pungent or ammoniacal. It is rather negative in character, faint in odor, mawkish, smelling perhaps more like soap than any other familiar substance.

"Sewer-air may esape very freely in our dwellings before its presence will be suspected, and that this happens very often there can be no sort of doubt. There are many reasons for this belief. One cause for such escape, and a very active one, is found in the difference of temperature between the interior of our houses and the interior of the underground sewers. A rarefaction of air and an upward current are thus induced. The joinings of the soil-pipes are imperfect from alternate expansion and contraction by exposure to hot and cold water, and, unless a free and safe vent is provided above, there must be leakage at these points. The air of the sewers, is also subject to pressure from the sudden influx of water in rain storms, and in seaboard towns from the action of the tide."

One of the general methods depended upon to ventilate sewers, is to connect the rain-water spouts directly with the sewer. Unfortunately the gases in the sewers are compressed during a heavy shower, and are therefor more likely to force themselves through the trap in the house drain, the spouts meanwhile are inoperative, as ventilators, being taxed to their utmost capacity in the discharge of their legitimate duties. The trap in the drain-pipe may be defective for the following causes. It may, as before stated, be forced by compression of the gas, or by difference of temperature between the air in the house and adjacent sewer. It is liable to be emptied by *siphonic action* from the sudden influx of a large amount of water into the drain, and again the water in the trap, even if it effectually seals it, is liable to become so saturated with impurities as to be valueless as a means of protection. The Board of Health of the City and Port of Philadelphia, in their annual report for 1874, say: "There is no subject in the whole range of public hygiene, which is more worthy of study than that which pertains to the planning and proper construction of latrines and water-closets. Much has been written, and many plans devised, with the object of securing the effectual removal and disposal of human excrement as well as the general drainage of large cities; yet, in American cities at least, the practical condition of things is generally defective, and sometimes terribly dangerous to the health of the inhabitant.

"It is a commonly received opinion, that a sewer connection is a sure remedy for the ills likely to be associated with drainage; and yet the medical profession will bear evidence to the many cases of typhoid and scarlet fever which are found to owe their existence to the admission of sewer gas into dwelling houses, which finds access by way of the water-closet. Recent experiments have fully shown how very short a time is requisite for some sewers gases, even under moderate pressure, to saturate the water contained in an ordinary trap, which must after this saturation has taken place, continue to exhale poisonous emanations into the honse with which it is connected. Dr. George Buchanan, Medical Officer to the Privy Council, London, in a paper gives a table with a list of 24 cities and towns provided with systems of sewers, and the effect on the death rate in each. He says, "Chelmsford is the only town in the list in which the general death-rate had increased. This is explained by the facts that the outfall of the sewer was badly constructed, and that the outflow of the sewerage was so far obstructed as to cause *backing up of the water into adjoining cellars and escape of* the "*mephitic vapors*" *into the streets and houses.* In Rugby and Carlisle, where the improvement had not been great, there had been some *backing up of the sewerage and some escape of the sewer gases into the houses;* and in Worthing, *where the death-rate from typhoid fever had decidedly increased, the sewerage flooded certain basements, and the foul gases escaped into the air.*" The International Medical Congress at Vienna, in 1874, the German Public Health Association, and the Sanitary Association of the Lower Rhine, have confirmed the truth of Dr. Buchanan's conclusions.

METHODS IN USE FOR VENTILATION IN VARIOUS CITIES.

Brooklyn. Sewers are ventilated in this city *directly into the streets.* It is very seldom any smell can be detected six feet from the surface of the street at the openings; there is rarely any complaint, and many persons are unaware of the existence of the ventilators.

London. Ventilates directly into the streets through gratings located at intervals of from 100 to 150 feet apart. Where the gases are very foul they pass through charcoal filters. Soil pipes are also extended through the roofs and left open above the tops of the houses, special pipes are also carried up the sides of buildings.

Liverpool. In the lower parts of the city, several thousand pipes have been carried from the sewer to the roofs of the houses, to be used exclusively for ventilation. Charcoal filters were used but were abandoned as they obstructed the passage of the gas. Ventilating shafts open also directly into the street, by the manholes.

Leeds. Ventilates directly into the streets, *the catch-basins being untrapped.*

Glasgow. Here the ventilation is defective, the gases rise to the highest part of the city, where the best houses are, and typhoid fever results.

Edinburgh. Has poor ventilation, and typhoid fever occurs on the high land, among the better class of people, at the summits of the sewers.

Paris. In Paris *the catch basins are untrapped and act as ventilators.*

Hamburg. Ventilates directly into the street *through the catch basins*, also uses rain water spouts, and gratings opening into the street, from which there is seldom complaint.

Dantzic ventilates directly into the streets through gratings.

Leicester. Ventilated into the streets, through shafts carried up the houses, and into boiler chimneys.

From the experience in Brooklyn and the various European cities mentioned it would seem that direct ventilation into the street is the simplest and most effective plan. This method is followed, to a certain extent, in the country where the manhole covers are frequently perforated, but they are liable to become clogged with dirt in summer, and covered with ice in winter, and thus cannot be relied upon. The safety of this method, as well as avoiding any nuisance, *would depend upon the multiplicity of the openings.* A great many ventilators could be secured by not trapping the catch basins, and by connecting with the lamp posts, the latter discharging the gas above pedestrians. In certain cases it might be well to use the charcoal filter, but it seems to be losing favor in England, and is considered, except in isolated cases, as unnecessary. In order to get a reliable opinion in regard to the subject I communicated with E. L. Stephens, Esq., for many years Borough Engineer for Leicester, England, and received the following reply:

URBAN SANITARY AUTHORITY,
Leicester, Nov. 15th, 1876.

MY DEAR SIR: I find that the charcoal gets choked so rapidly that I have removed the baskets almostentirely, and left the ventilators open to the sewers, except where they happen to come near crossings, where I retain the charcoal and change it frequently, the time depending on the position, *i. e.*, when the street detritus runs in freely, they required the more frequent emptying. In regard to the ice choking your openings, in the street surface, that is, of course, the same with us, though in a smaller degree but then my ventilators connected with engine chimneys continue to act as well as those carried up by the large public buildings. I have several attached to large lamp columns at cross streets or open squares. I think your idea of ventilating shafts at summits, especially if they are warmed by a ring of gas jets would be a great relief. We have no complaints of smell from the open gratings in the streets; *in fact they are becoming general everywhere.*

Dear Sir, Yours Faithfully

[Signed.] E. L. STEPHENS.

The right to carry up ventilating shafts on the sides of private buildings would be, of course, only permissive, and they cannot therefore be depended upon, although they should be used where practicable. Connections with boiler chimneys, which, by their elevation and temperature act as a powerful exhaust, is one of the most effective means of ventilation, and should be adopted where circumstances will permit. Catch basins, as ordinarily constructed, if untrapped, would be liable at times to have their shoots stopped with *debris*, or surcharged with storm waters. This can be avoided by using the shoot patented by M. K. Couzens, Civil Engineer, of Yonkers, N. Y. It consists of two pipes, one horizontal, or with a grade descending towards the sewer, the other vertical, with two arms, one extending above, the other below the connecting shoot. The upper arm has a float valve in the interior; the lower arm acts as the discharge, and extends low enough to draw from beneath the surface, and so prevent *debris* from entering the sewer. The shoot, or horizontal pipe, has double the capacity for discharge of the vertical one, and it is evident, can never be surcharged, but must always provide a passage for compressed gas to escape from the sewer. The float valve could easily be provided with a charcoal filter, if necessary, to purify the effluent gas.

DRAINS WITHIN THE HOUSES.

The individual while unable to inaugurate public reform, in the matter of drainage, can, meanwhile do much to protect himself, by proper arrangement and construction of his private pipes, and a few brief remarks may not be out of place in this connection. First, as to material. The main pipes in the house should be of iron, with *lead joints.* Cement pipe should never be used, as experience proves that, while water tight, the gas permeates it. Putty joints are liable to become cracked and broken from expansion and contraction of the pipe. The main pipes should never, as is often the case, be built into party walls, but should be so placed as to be readily accessible for examination and repairs. Lead is suitable for small pipes, but should be joined with the main pipe by means of a ferrule, which permits a lead joint being made. The main pipe should invariably be extended vertically through the roof and left open, which relieves the traps in the small pipe from pressure liable to force them. The water closet trap should be provided with a vent pipe. Edward S. Philbrick, C. E., of Boston, in a paper on House Drainage, published in the 7th Annual Report of the Board of Health of Massachusetts, says: "Most of the closets in our market have no provision for a vent-hole in the trap. The ne-

cessity for such a vent was pointed out by Mr. Roger Field, C. E. The following is from a private letter of Mr. Field, to the Secretary of the State Board of Health; in speaking of such a vent pipe. "The function it has to perform is simply that of admitting air whenever the closet is worked, so as to prevent the water being sucked out of the trap by the partial vacuum that would otherwise be created by the sudden rush of water down the arm leading from the closet to the soil pipe. This pipe in no way does away with the necessity of having the soil pipe properly ventilated, and, *vice versa*, the ventilation of the soil pipe by carrying it up above the roof does not do away with the necessity of the air pipe."

The pipes within the houses are themselves liable to become coated with matter which on decomposition evolves dangerous gases, and should be carefully, watched to detect defects liable to be produced by use. It should be understood that the system is peculiarly liable to infection during the hours of night; wash-bowls, in sleeping rooms, connecting with drains should *never* be allowed unless all precautions have been taken to have the fixture in proper condition. Plumbers cannot always be relied upon to do faithful work, and the details should be carefully inspected.

The writer was lately called upon to visit a house where the presence of sewer gas was suspected, and found, on examination, that the rain water spout from the roof extended into the cellar, where it terminated in a pipe of larger diameter connecting with the sewer, the space between the two pipes being open without any protection whatever. An upward current of air, sufficient in intensity to extinguish a candle, was steadily pouring into the cellar, from the sewer. Space will not permit further remarks on the subject. I would refer your readers who desire a thorough and comprehensive article on House Drainage to the paper by Mr. Philbrick already referred to.

Since the above was written I see by the return of a medical correspondent in the city to the State Board of Health, the following suggestive remarks in relation to *diphtheria*, one of the deadly diseases which has so often been traced in its origin to sewer emanations.

"It (diphtheria) has prevailed to a much larger extent during the last than any previous years. There has been an unusual number of severe sore throats, with and without exudation, with decided constitutional symptoms. The profession are not agreed in calling these cases diphtheria, some claiming that all cases of throat disease with exudation are diphtheria. Unfortunately we had no board of health or health office to investigate diseases. I saw one family of five children --all died. I have seen perhaps twelve cases in my own practice,—all of them in families well to do—modern houses with modern improvements. In one, the best to all external appearance, I found two waste-pipes had become obstructed, and *they were suffering from the effects of sewer gas. The pipes were immediately repaired, not another case occurring in the house.*"

In the paper mentioned as having been presented calling attention of its Council to the need of Sanitary reform in the matter of its sewers, which will probably remain forgotten among the archives of the City Clerk is the following testimony from a few of the many physician's statements therein contained.

Dr. B. says: "There is trouble from sewer gas at the house No.—— —— street. Beside the bad result from faulty condition of the pipes themselves, there is odor from the closets and there is constant sickness in the house. During this summer (1876) the principal sickness has been diphtheria, some *very putrid* cases. Eleven persons in the house have suffered and only four have escaped it. Beside there were two bad cases of dysentery in the house this season."

Dr. W. states: "Our sewers have been so recently built, probably we do not as yet suffer from all the evils that more time will bring. I know the trap does not in all cases or at all times resist the gas pressure, and what is more I fear that sometimes the trap is empty from suction through its long arm, and thus what is relied upon for protection becomes a trap indeed to catch and destroy us. Also if the sewers are not smoothly built inside, so that, when flushed, they will become thoroughly cleaned, *as time advances the evils will greatly increase.*"

Dr. D. testifies: "For the past ten months in particular I have noticed through our low street, and adjacent to the main sewer, and then again streets that have a steep grade, at the summit, a great increase in zymotic troubles, and I think they may well be attributed to sewer gas, from defective traps, and want of ventilation in the sewers."

Dr. McN. mentions a case under his care as follows: "On August 1st 1876, I was called to see Mrs. J., living on —— street, I found her suffering from an aggravated attack of dipenteric diarrhea, the case in its maglignancy indicating the presence of malaria. The patient not improving I summoned Dr. J. in consultation on the 5th of August, and from all he saw, and could learn of the case he agreed with me that if the case did not arise from malaria it certainly was aggravated by malarial influence. In my opinion the malaria proceeded from defective sewerage."

Voluminous testimony could easily be adduced to the same tenor as the above, but it is deemed unnecessary. The City Fathers may be brought to a sense of duty by a serious epidemic in their midst, but perhaps cannot be severely censured for not attempting to do away with an evil beyond their comprehension. The most sensible course would be to have a Board of Health in every city, by Legislative enactment, composed of a majority of medical gentlemen, associated with one Sanitary Engineer, and one member of City Council. If such a law were passed and enforced it is believed the death rate from zymotic diseases would be decidedly reduced.

DAMP HOUSES.

At the close, as we are now fain to hope, of a winter, which has not only been the wettest within the memory of man, but which, according to all accounts, has swum over the land in almost double the average depth of rainfall, there may perhaps be a good many people with whom the question of domestic damp is one of considerable melancholy interest. With one it is the rain that has "come through the ceiling." With another it is the same rain that has "driven right through the walls." Here the water has risen in the cellars, or in the "kitchens," until trim waiting maids have had to navigate them in a tub. There the mere "damp" has proved almost more unmanageable than any amount of palpable wet, by creeping up the walls of the rooms, or making the carpets and floorcloth as mouldy as old cheese, or actually procuring the importation, from some mysterious source under the floors, of fungi by the square yard, or by the pound, or by the bunch of mushrooms bursting playfully into the light through the crevices and crannies of the skirtings. If, therefore, we submit a few observations of a practical character upon some of these miserable manifestations of water in the wrong place, it is not at all unlikely that some of the sufferers may take heart of grace for some other wet winter, by reason of acquirement of a little elementary knowledge upon the unpleasant but solemn subject.

When a damp spot appears in a bedroom ceiling after a shower of rain, the cause is generally too simple for any elaborate explanation. There is a slate or a tile cracked or displaced; and it must be repaired, and perhaps the whole roof examined. But at any rate we may take occasion to allude to the well-known complaint that when the slater mends one slate he breaks three. There is a very intelligible fact at the bottom of this. A roof slate is the most brittle of all building materials—except of course glass. It has to be fixed in its place with two nails. If it should be fixed in any degree awry—and it is ten to one that it is—sooner or later the slate becomes cracked. This may be by frost, or even by wind; but it is obviously much the most likely to occur by the passage of a man's weight over the surface; and hence the mending of one slate may cost the breaking of three dozen as easily as of three if the slater be only sufficiently painstaking in his examination.

Where snow drives in through the crevices of the slating, this is only to be remedied by pointing or stopping up all those crevices from within—a thing which of course ought to have been done at the first in any circumstances wherein it must require to be done at the last.

The case of wet coming through the solid wall is a very common one. The rain is dashed against the outer surface by the wind; the water clings to the surface; the wind is simply so much pressure per square foot brought to bear upon this water; and if the porousness of the wall material—stone or brick—happens to be such as to allow this pressure to force the water through its whole thickness, the wet must of course appear inside. A south-west aspect in an exposed situation in the country, with a sandstone wall, or with a pretty red-brick facing, is eminently favorable for this transmission of the wet; and indeed a strong wind will carry it sometimes straight through as much as 18 inches in thickness of solid brickwork, or a good deal more of solid stonework—one of the most experienced of masons going so far as to say that he knew no stone in the British Islands (granite not being overlooked) which would hesitate to carry the damp through the thickness of 3 feet if fairly put to the test. Constructive precautions against this kind of damp-plague are very well understood and constantly put in practice. To form a hollow wall is the commonest plan. To line the inside of a stone wall, whether hollow or not, with hard brick is a thing often done. To avoid in every possible way the carrying of header stones through the whole thickness of the wall is a self-evident rule. To batten and lath the inside, instead of plastering directly on the stone or brick, is most effectual. But it must be borne in mind that this battening—which in fact leaves an inch or so between the wall and the plastering— only conceals the damp after all; for even if it be nothing more serious than a case of the mere absorption of passive moisture by soft stone, whatever amount of wet actually comes through to the inner surface is obviously left there behind the lathing, to evaporate as it best can.

To remedy the defects of a wall of this class is now an easy task. The ends of head-stones may have to be cut away and patched; or the entire surface may have to be re-plastered on battening and lath; or some kind of paint or paper or the like which is impervious to water may be applied to the surface—although it is difficult to see how anything of this kind can be really effective except in cases of a very slight moisture, affecting for instance the wall-paper and no more. It may be fairly alleged, however, that the application of certain washes or paints externally may prove much more serviceable. In this instance the first access of the damp may possibly be prevented, whereas in the other it is only its exit that is attempted to be stopped.

Where the basement rooms become flooded, this is manifestly due to some one of half-a-dozen causes of an altogether different character which it would be impossible here to discuss. One of these causes, however, may be alluded to as being exceptional in its nature and in its effects, namely, the rising of underground water at almost unexpected times. This occurs generally in marly or gravelly soils where there is a substratum of clay. This surface-bed is connected, perhaps at a considerable distance, with similar soil at a higher level, the clay substratum extending from the one locality to the other. The result is, after rain has fallen heavily on the remote higher level, that it finds its way along the back of the under-clay to the lower level and there breaks out in the form of land springs. If this be, as it probably will be, an incurable evil (unless one is prepared to make the basement a waterproof tank), there may at least be some sort of dismal satisfaction in understanding the reason of it.

The ascent of damp from the ground through the substance of walls is far too common both in town and country. The process of it is easily described. The foundation of the wall being built of some soft quality of brick or stone, the water will rise directly through this material by capillary attraction if encouraged. Consequently when the soil comes to be wet below, the warmth of the house within is quite sufficient to encourage the water so to rise. The common preventative is to introduce in the substance of the wall during the course of building a layer of some damp-proof material, such as slate or asphalte. This keeps back the ascent of the moisture and leaves the foundation alone saturated. But it is plain that if this simple measure be not carried out at the first it is generally

almost impossible, or quite so, to adopt it as a remedy after the defect appears; and all that can be said is that, unless the expense can be encountered for inserting a layer of slates by the laborious process of cutting out the stone or brickwork foot by foot, there is perhaps nothing else to be done but to try the makeshift of applying impervious paint, or metallic cement, or whatever other nostrum may offer.

When damp is found to ascend into the house from the whole surface of the soil under it, that is to say, probably through the floors of the basement, this is not difficult to understand. The soil being charged, as matter of course, with atmospheric air, when the temperature without is lower than within—as in the night-time—the cool external air necessarily forces its way into the warm house by every means of access, and, amongst the rest, through the subsoil. If, therefore, this subsoil is damp, the consequence may be that a mouldy smell will manifest itself within the house by reason of the ascent of air from the ground, and it is more than probable that this smell will also indicate the presence of foul gas as well as mere water. The remedy for all this is to take up the floor and make an impervious bed or surface underneath as a covering for the soil. Concrete is no doubt the most handy material for this purpose, but it ought to be good or it may fail to stop either the moisture or the gas.

Our last subject shall be that which is commonly called dry-rot. This is a species, or rather any one of several species, of fungus, which, when established on any surface of wood, runs with rapidity over the whole, and at the same time throws its filaments into the substance. A piece of wood thus attacked by dry-rot soon becomes coated over with either a delicate fibrous tissue or a coarse leather-like skin, and is consumed throughout by what is very expressively called by the name of bears-rot. The plant itself happens to be especially fostered by a combination of damp and warmth, and still more signally when these combined conditions exist without the presence of ventilation. Logs of American pine, for instance, when taken from the hold of a vessel, are not unfrequently found to be affected more or less with dry-rot, and it is well-known that the most serious standard example is when the fungus attacks the timber of a ship for want of air. As a theoretical principle, the provision of ventilation effectually prevents the disease from being initiated; and as a general rule, it is even asserted that the subsequent admission of air will check its progress, and indeed cure it so far as it happens to be curable. The fungus, in a word, dies in fresh air. When, however, it has come to any head before discovery, it is scarcely necessary to say that the floor must be taken up, and the skirtings and other parts removed, and every infected portion cut away carefully for the substitution of sound wood. It is also desirable to apply a wash of some such liquid as diluted carbolic acid. Beyond all other things, a circulation of air must be set up by the insertion of air bricks or whatever else under the floor, so that, whether the air will kill the fungus or not, it may at least prevent it from spreading.

No doubt there are other forms of the domestic damp disease which one and another reader may be able to recall to recollection from wretched experience, but probably these are the chief. At any rate the man is always to be pitied who lives in a damp house—unless he be some hardy amphibious person who can afford to say that he disregards such trifles. Into the details of what diseases of the body—and of the mind—an average Englishman becomes liable by dwelling in damp we do not desire to enter; the discomfort of the thing or even the objectionable appearance of it, is enough for our purpose, and we are certainly offering good advice to every one who have this to complain of when we say that he ought to get at the root of it as soon as he can, and so far as it is possible, make an end of it.—*The Architect, England.*

O. B. GREEN & Co. and W. G. COX have been awarded the South Chicago Drainage Contracts.

J. K. BEATY has the contract for building the 41st street sewer Hyde Park, Cook Co, Ill., at $27,426.

THE West Side Gas Co. of Chicago, will accept $2 per 1000 feet of gas, from the City, the contract to be from Oct. 1, 1876, to May 1, 1878. The Southside Co. will take $1.65 per 1000 feet

CORRESPONDENCE.

RICHMOND, VA., *July 4th, 1877.*

Editor ENGINEERING NEWS:

SIR.—Although the question of *Subscriber* as it first stood was misapprehended by me, his explanation of it still shows that the answer can be found in some of the same texts referred to—Rankine, pages 687–688 and Weisbach, pages 959–963.

If the forms and dimensions of Sewers as well as Culverts of all kinds are not determined by the same principles, I shall be glad if *Subscriber* or any one else will indicate the difference. Very respectfully,

ANOTHER SUBSCRIBER.

RECORDING PLATS.

Editor ENGINEERING NEWS.

SIR.—I have had much experience in using county records of maps of sub-divisions of cities and villages. They are so often lacking not only in that plainness and style of execution which is essential in every map, but are so poorly copied that they are often misleading in essential features. It is not too much to say that they are as a rule, every way inferior to the maps of which they purport to be a copy, and I think I am safe in saying that nearly every surveyor has experienced more or less trouble and annoyance on this score. The next question is, what can be done to bring up the standard, and make these records what they should be? Let me suggest a new departure. Let the map made by the surveyor be filed—not rolled up and laid away in a pigeon hole or drawer to get mislaid or carried away—that wouldn't do—but attached by eyelets, seals or otherwise to the leaves of a scrap book, provided for the purpose. This book should of course be well bound, be of suitable size, the filing maps, etc. properly certified and fully indexed, and a proper fee allowed the officer for their custody. The map or plat found in the recording office is the one the public depend upon for their information, and I am satisfied some such plan as indicated would be not only perfectly feasible but a great improvement on present practice. The Canadian practice, is I understand, to not only require a record but to file a duplicate of the original map.

APOSTLE.

FERRYSBURG, OTTAWA CO., MICH., *July 4th, 1877.*

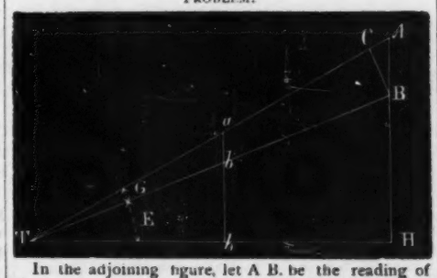
Editor ENGINEERING NEWS:

SIR.—As the subject of "Telemeter Surveying" is attracting somewhat of the attention, which its merits deserve, allow me to contribute my mite to the general fund of information.

I am induced to this, from seeing in Messrs. Buff and Berger's Manual of Surveying Instruments, a notice of a new attachment, called the "Gradienter," for the Engineer Transit. This attachment must eventually supersede the "Stadia wires," for the following reasons: It is of less cost than the "Stadia Hairs. It has a wider range of usefulness,—it can measure different angles, and greater of all, it refers the zero of horizontal measurement to the plumb line of the transit,—thereby dispensing with the correction for focal length of object glass of telescope.

But the greatest reason for offering my "mite" is the fact, that I am *not able to find in any of our works, or popular journals*, published in the interest of Engineers and Surveyors, *one correct solution of the Problem* under consideration.

PROBLEM.



In the adjoining figure, let A B. be the reading of the rod, intercepted between the two visual lines B T, and A T, from the telescope at T. Let E be the angle of elevation T B, to the lower reading; and G. the angle subtended by the rod, and measured by the "Gradienter"—, E having been measured by the vertical arc, and A B being vertical.

Required the horizontal distance H T.

Solution.—Draw B C perpendicular to A T, then, because A C B is similar to A H T.

$$B C = A B \cos (E+G.), \text{ and}$$

$$B T = \frac{B C}{\sin G} = \frac{A B \cos (E+G.)}{\sin G.}, \text{ and}$$

$$H T = B T \cos E = \frac{A B \cos (E \pm G^{*}) \cos E}{\sin G.}. \qquad (1.)$$

This equation is well adapted to the use of logarithms,—the second member being composed entirely of factors; and furthermore, it has the merit of being *rigorously correct*, and of less trouble to solve, than some of the approximate methods.

* On a "down grade," the sign of G. will be —, minus.

Again (referring to the same figure), take $T h =$ unity, and draw $h a$ perpendicular to T H, then $h b$ and $h a$, are respectively the tabular tangents of the angles E and (E+G). H B and H A, are also tangents to the same angles, on another radius.

Then because the triangle $a T h$, A T H. are similar, the ratio

$$\frac{A H}{a h} = \frac{A B}{a b} = \frac{T H}{T h} = T H = \text{distance required.}$$

But A B is given, in the reading of the rod; and $a b$, (which is tan. (E+G)—tan. E), is its tabular analogue, and is to be found from the table of natural tangents. Hence the following *rule*:

$$H T. = \frac{\text{Reading of Rod}}{\text{Tan (E + G)} - \text{Tan E}}. \qquad (2.)$$

This second equation, besides being *rigorously accurate*, is derived from an analysis, so simple and elementary, as to be within the reach of the youngest student in engineering. Moreover, it is easy tabulated.

Following, is the solution of an example from page 25 of Buff and Berger's Manual, by both of the preceeding equations.

Example,—by Equations (1.)

Rod A B = 2.752 feet,		log.	=	439648
Angles (E+G) = 18°,54'.23''	cos.	"	=	9.975914
" E = 18°,20'.	cos.	"	=	9.977377
" G = 34',23''	com. Sin.	"	=	1.999916
Horizontal Dist. H T, = 247.1 feet		"	=	2.392855

Same Example, by Equation (2.)

Tan. (E+G)	=	.342501.
Tan. E,	=	.331364.
Diff. Tangents =		.011137.

Rod = 2.752

Diff. = .011137 = 247.1 feet.

If the two preceding equations are deemed too complex for field work, we may change No. (1.) into the following, which is *very approximately* correct,—giving results slightly *too large*,—remembering the angle "G." is so adjusted, as to embrace unity, at distance 100, from the plumb-line of the transit, unless otherwise specified.

$$\text{Hor. dist.} = 100 \cos^2 (E. + \tfrac{1}{2}G.) \text{ Rod.} \qquad (3.)$$

By this formula, the preceeding example, becomes $100 \cos^2 (18°37'11'') 2.752$ feet = 247.15 feet.

The formula for the table of divisors, on page 28 of the ENGINEERING NEWS, vol. II. is correct, and shows much skill, but unfortunately, as the angle of elevation refers the horizontal measurement to the plumbline of the transit, while the gradienter angle, being measured by the stadia hairs in the telescope, refers to a point in *front* of the telescope. the two different distances are combined by the same reading of the rod,—thereby introducing non-precision. Moreover, it will be seen by reference to equation (2.) that is as easy to deduce the horizontal distance from the original reading of the rod, as from the reduced reading.

On page 47 of the same vol. of the "NEWS" is given a formula for horizontal distance. This is erroneous, from fallacy in the logic by which it was deduced, and therefore of little account.

I can enumate other plans, which might, perhaps be called fair for good guessing.

With the wonderful precision of modern instruments, it is needful to have accurate formula, or the engineer will fail to benefit by the skill of the instrument maker. If what I have written shall stir up a little interest in this meritorious method of measuring distances, I shall be paid for my trouble.

H. C. PEARSONS, *County Surveyor.*

Note.—In taking angles of depression, the telescope should be trained first to the *upper* readings of the rod,—then further depressed by the gradienter screw, for the lower reading. If this precaution is not observed, the signs of the angles E. and G., must be modified to correspond. H. C. P.

AMERICAN IRON AND STEEL.

The annual report of the Secretary of the American Iron and Steel Association has just been made public, and includes statistics of the American and foreign iron trades to January 1, 1877. From the report it is learned that the production of pig-iron in the United States in 1876, was 2,093,236 net tons, against 2,266,581 tons in 1875, 2,689,413 tons in 1874, 2,868,278 tons in 1873 and 2,854,558 tons in 1872. From 1873 to 1876, the decrease has been 775,042 tons, or 27 per cent. If the rate of decrease which marked the period from 1873 to 1876, were to be continued, the production of pig-iron in the United States would entirely cease in 1884, less than eight years from the present time. At the close of 1874 the stock on hand amounted to 795,784 net tons; at the close of 1875 to 760,908 tons, and at the close of 1876 to 674,978 tons. It is believed that the production of pig-iron in 1877 will be at least as great as that of 1876. Pennsylvania made almost one-half of the total product in 1876, namely, 1,009,613 tons, or 42.2 per cent. Ohio came next to Pennsylvania, making 403,277 tons, or 19.2 per cent. New York decreased its production from 266,431 tons in 1875, to 181,620 tons in 1876. The whole number of completed furnaces in the country at the close of 1876, which were either active or capable of being transferred to the active list on short notice, was 714 against a similar total of 713 at the close of 1875. Ten new furnaces were completed in 1876, and nine old furnaces were abandoned. At the close

of 1876, 236 furnaces were in blast and 478 were out of blast. The productive capacity of the furnaces of the country is at least twice the actual yield of either of the last two years.

The probable total consumption of pig-iron in the United States in 1876 was 2,172,503 tons; of this amount 2,093,236 tons being American iron, and 83,072 tons imported. The total production of all kinds of rolled iron in the United States in 1876 was 1,921,730 tons. The decline for American rails has not been so marked as to justify the prognostications of evil that have been uttered on every hand, the difficulty being that Bessemer rails have been largely substituted for iron rails, and not that rails of any kind have not been wanted. In 1876 there were rolled 879,629 net tons of rails, an increase of 87,117 tons, or 11 per cent. over 1875. Of these 412,461 tons were of Bessemer steel rails. The production of steel rails in 1876 was 13,036 tons. Pennsylvania led in this production, with Illinois next, Ohio third, followed by New York. Sixty-four rolling mills in thirteen States made cut nails and spikes in 1876. The number of machines contained in these mills was over 3,800, although the whole number were not employed. The total production of cut nails and spikes in 1876 was 4,157,814 kegs, against 4,726,881 in 1875, 4,912,180 in 1874, and 4,024,704 in 1873. The production of bar, angle, bolt, rod, hoop, plate, and sheet iron in 1876 amounted to 834,214 tons. The probable consumption of rolled iron, except rails, in 1876 was 1,067,111 tons. The probable consumption of rails in 1877 was 879,916 tons. Eleven Bessemer steel establishments were in operation in the United States in 1876. Forty-seven establishments made steel other than the Besssmer in 1876, the net product being 71,178 tons.

The value of iron ore imported into the United States in 1876 was much less than in some previous years. New York, received $12,030 worth; the lake ports, $32,446 worth; Philadelphia, $7,692 worth; other ports $673 worth. A statement from the Register of the Treasury shows that there have been built in the United States since 1866, for American owners, 251 iron vessels of all sizes, having a total measurement of 197,500 tons. The tonnage for 1876, was 21,346. The number of miles of railroad in operation at the close of 1876, was 77,514; being an increase of 2,856 miles over 1875. Of the railroad mileage of 18,6. nearly one-fourth was narrow gauge. At the close of the year the country had one mile of railroad for about every 575 inhabitants. In the year ended December 31, 1876, we exported iron and steel products of domestic manufacture aggregating $15,997,643 in value, against $20,417,635 in 1875, $20,458,732 in 1874, $16,687,754 in 1873, $14,360,617 in 1872, and 15,206,179 in 1871.

The report says: "The hopes that have been indulged in by many persons that this country would soon enjoy a large export trade in iron and steel products have not been realized, and the principal reason why they have not been realized is due to the fact that other leading iron producing countries still manufacture the coarser forms of iron and steel cheaper than we do. But there are other forms of iron and steel that we could introduce more largely than we do into foreign markets in successful competition with foreign manufacturers, and we repeat the remark we have heretofore made, that the way to extend our markets and increase our sales abroad is to display more commercial enterprise and tact than has been customary with American iron and steel manufacturers."

The gross tons of the aggregate yield of the mines and furnaces of the Lake Superior districts in 1876 were 977,233 tons of iron ore, and 61,911 tons of pig iron, valued at $5,397,765. The iron and steel product of Pittsburg and Allegheny county, Pa., in 1876 was 284,036 tons of rolled iron and 32,311 tons of steel. The stock of pig-iron unsold in the country, December 31, 1876, was 674,798 tons.—*N. Y. Times.*

A NEW KIND OF RAILROAD.

A new kind of railroad has been suggested by some English capitalists and engineers. The plan proposed is called "the Pioneer Railway,' and consists of a low fence of continuous girder, constructed of wood or iron, as desired, supported on edge upon posts or pillars, and surrounded by a single rail (not a single line of rails); the engine, coaches and cars running on this rail, and sitting astride of the fence, after the fashion of the panniers or packs on a camel or a mule. At any incline up to one in ten is possible, in consequence of the method of driving adopted, no expensive surveys are required, nor levels, except of the most simple kind. It is estimated that with the railway made entirely in iron the cost will not exceed $7500 per mile, including the proportion of rolling stock. By abandoning entirely the use of vertical adhesion this system is entirely independent of weight, in as far as driving power is concerned and hence locomotive engines can be made as light as is consistent with obtaining the necessary power from them. The horizontal grip is given by mechanical appliances, which affords the means of varying the amount of pressure at will, in proportion to the gradient to be traversed, and therefore to the load to be drawn. A light locomotive engine on this system means a light construction of road, but not necessarily, as in the narrow gauge systems, a seriously diminished proportion of traffic hauled by it. The weight is, as nearly as possible, uniform throughout the train, and amounts, when loaded, to from 15 to 25 cwt. per wheel.

The "Pioneer" is thus a homogeneous caravan, all the links of it being of similar weight, and the road to carry it being constructed at an outlay governed by the nature of the traffic, and in no way measured by the arbitrary weight of a conventional locomotive, whose dead weight alone would equal that of a whole "Pioneer," freight included. It possesses the very important element, from a commercial point of view, of providing a supply never in excess of the demand; freight stations and porters, passenger stations and signals, will not be required, there will be no points of crossings, derailment is impossible, and no outlay for fences, hedges, or retaining walls need be incurred, because in public and exposed places, as well as for the passage of roads and rivers, the viaduct is raised to any required height. The main intention underlying the plan is to provide a mode of communication and transport which is cheap, elastic and efficient, having a low first cost, easily and rapidly erected and removed, and being capable of paying with the scattered or meagre traffic to be obtained from thinly populated and undeveloped countries.

A NEW FIRE CISTERN.

A new fire cistern invented by Mr. R. T. Scowden, City Engineer, was tested Wednesday afternoon at the corner of Thirteenth and Magazine streets, and proved to be entirely satisfactory. This cistern is entirely different from any fire cistern ever used before. It is constructed to hold three hundred barrels of water; the body of the cistern instead of being perpendicular is horizontal, lying parallel with the course of the street, cylindrical in form, the walls being of brick and cement, thirteen inches in thickness. The tank is sixteen feet long and ten feet in diameter, with the crown twenty-four inches below the surface of the street, the two outlets being near the ends. The idea of this plan of cistern is to obtain more than one outlet, which is impossible in those now in use, so that a great number of engines can be operated from one receptacle. Another advantage claimed for it is that the cistern, from the nature of its construction, can not be crushed in from the street above. Every one who saw the test were much pleased, and were ready to acknowledge the superiority of this cistern over those now in use. It is likely that they will be extensively adopted in the future.

The following report, made by the City Engineer to the Mayor gives a clear idea of the test:

LOUISVILLE, *June 27, 1877.*

Hon. Charles D. Jacob, Mayor:

DEAR SIR—According to appointment, at 5½ o'clock this afternoon, with characteristic promptness Captain George W. Levi applied the torch to four of his steamers, to test the supplying capacity of the new fire cistern at Thirteenth and Magazine streets, and in a few moments the engines were throwing 1,600 gallons of water per minute from 1½ inch nozzles, while the water in the cistern (which was 2 feet 9 inches below the cistern cap when the pumping commenced) gained steadily upon the engines until the cistern freely overflowed, clearly demonstrating, that a six-inch distributing pipe four miles from the water-works, will abundantly supply six fire-steamers with water, obtaining thereby, for the fire department concentration of their force and power and a double fire capacity, besides, largely reducing the length of hose lines, which materially adds to efficiency and economy. The simplicity of the new fire cistern, combined with its superior strength and small size, renders it further desirable, because it can be located in the side of the street, where neither sewers, water nor gas pipes need molest or injure it. Respectfully,

R. T. SCOWDEN, City Engineer.

"THE ODOROUS PINEY WOODS."

These words caught our eye as we were lazily glancing through *The North and West Illustrated*, and they caused us to long for a trip to the home of the 'piney woods" Without much thought as to where we should stop, we took our start from the good city of Louisville, Ky., and soon found ourselves at Chicago. There we found but one route that could give us what we were looking for, and found that to be the new Chicago, St. Paul & Minneapolis Line, that led through prairie and meadow, through hill and valley, along great lakes and streams, and finally into the depths of the pine forests of Wisconsin, and so on to St. Paul and Minneapolis. Buying our tickets we started and left the Canal and Kinzie streets depot of the Chicago & North-Western Railway, and passed through many pleasant villages, such as Irving Park, Desplaines, Barrington, Crystal Lake and Woodstock, and reached Harvard, thence to Beloit, Hanover and Madison, where we are 140 miles from Chicago, and at the capital of Wisconsin, a city of over fifteen thousand people.

The city is pleasantly situated on an isthmus about three-fourths of a mile wide, between lakes Mendota and Monona, in the centre of a broad valley, surrounded by heights from which it can be seen at a distance of several miles. Lake Mendota lies north-west of the town, is six miles long and four miles wide, with clean, gravelly shores, and a depth sufficient for the navigation of steamboats. Lake Monona is somewhat smaller.

At 176 miles from Chicago, and 36 miles from Madison, we reached the celebrated Devil's Lake. This is a beautiful body of water, surrounded by precipitous mountains on every side, except at two points, one being at the southern end, where the railroad enters the lake basin, and the other at the northern end, where the railroad finds exit from the basin of the lake. On every side of the lake you see "rock piled on rock" in every conceivable form, and in immense columns, pillars, piles and masses of very great magnitude and height. The railroad runs along the shore of the lake on a bed that was literally blasted out of the sides of the mountain. From the car windows all the beauties of this wonderful and weirdly mysterious region can readily be seen. This was the home of Minnawaukene, a beautiful but unfortunate Indian maiden, and many legends are related of her by the simple hearted and kindly people of the vicinity. This lake is a famous summer resort, and to it the people for many miles around come for a pic-nicking, sailing, boating, fishing, and other sports.

At Baraboo you reach the Baraboo river, and from thence pass along its valley for many miles.

At Elroy you are 212 miles from Chicago, and at the southern terminus of the West Wisconsin Railway. From Elroy you hasten northward on the new and admirable track of the West Wisconsin road, and soon reach the great pine woods, which have rendered Wisconsin celebrated the world over. Into the heart of the pine lumber region you speed, passing through Black Falls, Humbird, Augusta, Eau Claire, Menominee, and other noted *lumber* towns, and finally cross the river St. Croix at Hudson. This river is the dividing line between Wisconsin and Minnesota. A few miles beyond, you reach a branch to Stillwater, a flourishing town on the St. Croix river. A fifteen mile ride brings you to St. Paul, and here you rest, or push on eleven miles further to the active, bustling cities of Minneapolis and St. Anthony.

At St. Paul you can make close connections, via the Lake Superior & Mississippi Railroad, for Duluth, Morehead, Bismarck and other points on the line of the great Northern Pacific Railroad, and also with the St. Paul and Pacific Railway, for Breckenridge, Fort Garry, and points in Manitoba.

On the line we have hastily sketched, you have a variety of scenery—the quiet, beautiful prairie country of North-eastern Illinois; the rolling farming country of Southern Wisconsin; the wildly romantic mountain scenery of the Devil's Lake country; the breezy, odorous "piney woods," with their busy mills, active towns, and numerous logging camps; and the charming river country of the St. Croix valley. A greater diversity of country cannot be found anywhere in a journey of the same length. You will find comfortable, cleanly and commodious dining stations and hotels along the line, at which ample time is given for all meals.

One management controls the route, and Pullman Palace Sleepers run through to Minneapolis via St. Paul. It will be seen that this line runs nearly due north-west from Chicago to St. Paul, and is but a few miles longer than an air line, and *it is the shortest practical route overwhich a railroad line can be built between these points.* This assures the passenger the quickest time that can be made. *No other route is or can be made as direct.*

We are now settled down by a quiet brook where we daily pull from the "vasty deep" the speckled beauties we have heard so much about.—*The Courier.*

The total length of the Sutro tunnel from mouth to face of header is 18,012 feet.

The Hill Sewer Pipe Company, of Akron, sold nine miles of six inch socket pipe in addition to traps and elbows, between March 20th and June 20th of this year.

Nineteen bids were received for building the Distributing Reservoir at Pawtuchet, R. I. The contract was awarded to J. B. Dacey & Co., of Boston. The highest bid was two and a quarter times the lowest.

A great work on bridge building, entitled "Die Brucken der Gegenwart," by F. Heinzerling, with many illustrations of the best iron bridges in Europe and America, is published at Aachen, in Switzerland.

Mr. E. S. Chesbrough, City Engineer of Chicago, contributes an article to the eighth annual report of the State Board of Health of Massachusetts, on "Sewerage: Its advantages and Disadvantages, Construction, and Maintenance."

The Secretary of the Department of Public Works, of Chicago, advertises for bids for machinery for the Fullerton avenue conduit. The engines are in be erected on a 150 foot lot, corner of Fullerton avenue and the North Branch. The estimated cost is $60,000. The specifications call for two vertical, direct-acting, single-cylinder, condensing engines, and three boilers, complete in all their parts. The duty required of the engines is 70,000,000 foot pounds. The machinery is to be completed and put into operation before Nov. 1, 1877, the contractor to operate the engines twelve months before receiving all his pay. At the end of a year a trial test will be made, and, if they do their duty, they will be accepted; but if the engines fail to perform the duty a reduction of $300 will be made for each 1,000,000 foot pounds that they fall short of the required 70,000,000.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 177.*)

To make good road metal from hard compact stone, the jaws should be set from 1¼ to 1½ inches apart at the bottom. For softer and for granular stones they may be set wider.

A cubic yard of stone is about one and one-third tons.

In getting an engine to drive one of these Crushers, it is advisable to have one of greater power than just what is stated in the table as required. It is much more economical to use 9-horse power from a 12 or 15 horse, than from a nine or ten horse engine. The machine may be driven by any power less than that given in the table, yielding a product per hour smaller in the same proportion.

10x7—(No. 2.) Will take in a stone 10 inches wide and 7 inches thick, and is quite an effective machine. It may be set to break to any size down to ¾ inch, and can be used for the same purposes as the 10x5, but receiving pieces two inches thicker is preferred in many cases. It will do a good deal in the preparing of road metal. It is one of the most salable sizes.

15x5—(No. 3). This machine takes in a stone only 5 inches thick, but being 15 inches wide is a more effective machine than the 10x5, but is used for same purposes when a larger product is required.

15x7 and 15x9—(Nos. 4 and 5). These are the sizes most salable, and best adapted to general purposes. They are the sizes almost uniformly used for breaking stone for McAdam roads and Ballasting railroads and for concrete. They are also used extensively at smelting furnaces—also at copper and other mines, to take the product of the coarse breakers and reduce it to proper size for feeding under the stamps.

When broken by hand and for country roads, the stones should be broken on the storage places already mentioned, which are to be established along the side of the road every 200 to 250 feet. The laborer is not to pound the stones on a heap of such, but to use one large stone as a sort of anvil to break the others on. He is to use a light hammer, except for pieces containing more than four or five cubic feet, and may use a ring with a handle attached to hold the stone he desires to break.

In order that the road shall get an even surface, the macadam must all be of one size, and the proper size for the macadam depends on the degree of hardness of the rock. If too small, it turns to dust; if too large, the top will not pack even. The size is regulated by the use of a ring as a gauge,– every stone being obliged to be capable of falling through this ring in any direction it may be dropped. Hard stones should be one to one and a quarter, softer ones one and a half, and the softest two inches in diameter. Larger sizes give less perfect roads. In loading and otherwise handling macadam, a many and close-pronged pitchfork should be used instead of a shovel, so as not to mix in any earth or sand, and so sift out the stone dust and chips.

The macadam being properly prepared and loaded up, it is spread over the foundation in two or three successive layers. Each layer *should* be rolled, but the top and last one *must* be rolled to make a good road. Nor will rolling alone do the work. Two other helps are needed: the use of a building material, to act as a cement between the broken stone, and sprinkling. It is difficult to prescribe in words just what to use as binding material, and just how much to sprinkle and roll; common sense will in most cases be a safe enough guide. In the macadamized streets of Paris the rule is to roll till a single piece of macadam placed under the roller, will be crushed, without being pressed into the road surface. Gravel somewhat mixed with clay by nature, but not too much, is probably best as a building material. Clean coarse sand is very good. Other substances will do, where it would cost too much to procure either of the above.

A late writer in the "Journal of the Society of Civil Engineers and Architects," at Hanover, calls attention to the practice in Bohemia of making foundation roads by setting first the foundation course, spreading a thin layer of the binding material on that, and the broken stone on top of this again. The subsequent rolling has the effect of forcing the binding material, slowly and gradually, from beneath upwards into and through the broken stone. The writer states that he himself has tried a system of road construction that consists of a combination of the two methods hitherto used, with good results, namely: first, a foundation course, a thin layer of binding material on this, then the broken stone, another thin layer of binding material, and then wet down and roll.

The subject of rollers is one demanding some attention. In general, people are apt to over-estimate the value of a roller with respect to its weight. It will be evident on reflection that a roller should be as heavy per inch in length of roller, as a loaded wagon wheel is per inch of tire; or, in other words, if we have a wagon with tires two and one-half inches wide and on each wheel a load of say one ton, the roller should weigh two-fifths ton for every inch in length, or a roller three feet long should weigh about fourteen and one-half tons, or else a wagon as above described would exercise more pressure on the road-bed per square inch than the roller, and consequently would cut into the rolled surface and produce ruts.

The proper width of tire, or proper load upon any vehicle, for a given width of tire, is a question that occasionally attracts attention. Bokelberg, a good German authority on the subject, in an article in the "Journal of the Society of Civil Engineers and Architects," at Hanover, 1858, comes to the conclusion that for four-wheeled vehicles, upon a broken stone road, the loads should vary with the widths of tires, as follows:

WIDTH OF TIRES. INCHES.	LOAD IN LBS.
2 to 3	5,000 to 6,600
3 " 4	6,600 " 8,800
4 " 5	11,000
5 " 6	13,000
6 " 7	15,000
7 and over.	16,500

Further conclusions are: that the best width of tire, measured when they are new, for the transportation of freight, is from four to seven inches; this width being best for the easy traction of the load no less than for a minimum wear of the road surface. To make the tires wider than seven inches does not diminish the force required to move the load, and unnecessarily increases the dead weight of the wagons.

Road-rollers are of two principal kinds: those pulled by horses and those propelled by steam. The latter are for many reasons the best. In the first place they can be made as heavy as desired, without proportionally increasing the cost of propelling them, and being self-propelling, the only track they make is that of the roller, whereas with horse rollers, the hoof-marks of the horses are a great objection. Then again in the amount of work they will do at a certain cost, they excel horse rollers. They may be briefly described as a sort of locomotive mounted on three or four very broad and heavy wheels, these latter being the road rollers.

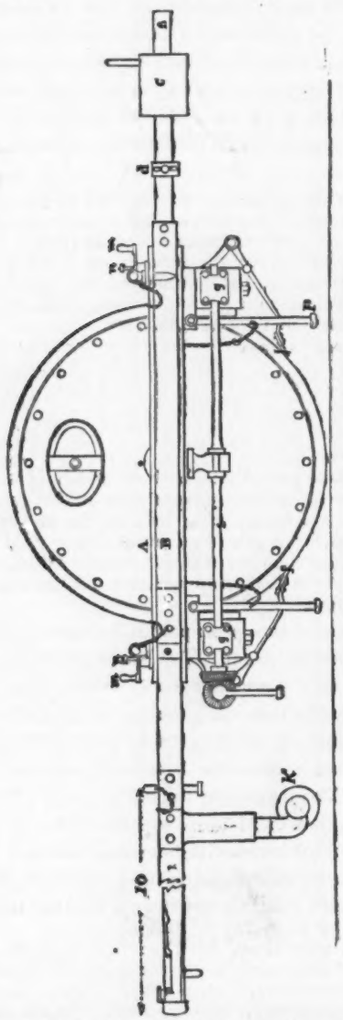
An excellent pamphlet on the subject of steam road-rollers is the "Report on the Economy of Maintenance and Horse-draught through Steam Road-rolling," by Frederick A. Paget, E. & F. N. Spon., 1870. Readable articles on the same subject are: "Steam Road-roller," Engineering, Oct. 4, 1867. "Paris Kind of Steam Road-roller," Engineering, May 7, 1869. "Cost of Operating Steam Road-rollers," Engineering, June 18, 1869. "Good Steam Road-roller," Engineering, Jan. 14, 1870. "Economy of Steam Road-rolling, Engineer, April 1, 1870. "How to use the Road-roller during alternate Thawing and Freezing," Annales des P. & C., 1877, p. 125. In the spring and fall on finished roads, and occasionally during the first construction or reconstruction of roads, the surface becomes *sticky* mud, and to roll the road at those times, or to travel on it, tears up the covering and spoils the whole. If at such times the *roller be constantly sprinkled and kept wet* while it is being used, it will shed the mud or road covering, instead of tearing it up, and will consolidate the road in a very superior manner. And this method requires less water (only about one gallon to one and a half gallons per 100 feet of travel) than the method formerly used under these circumstances of converting the *sticky* mud into liquid mud, by copiously wetting down the whole road.

There are several varieties in use in France and England, and two at least of the English kind have been imported into this country, one for the New York Central park, the other for the Arsenal Grounds in Philadelphia. The cost of the Central Park

steam road-roller made by Aveling & Porter, of Rochester, Kent, England, was about $5,000, set up in New York, and the amount of work it will do in one day at a running expense of $10, has been given as equal to that of a seven-ton, eight-horse road-roller in two days at $20 per day, or, in other words, it will do the same work at one quarter the running cost and in one-half the time, of a first-class horse road-roller.

Since 1870 many other steam road-rollers have been bought by various parties in the United States. Thus there is one owned by Daniel Brennan, a road contractor, in Orange, N. J.; the city of New Haven, Conn., has run one with great success for several years; after many years of agitation on the subject, the city of Boston now owns and operates a steam road-roller; and so on.

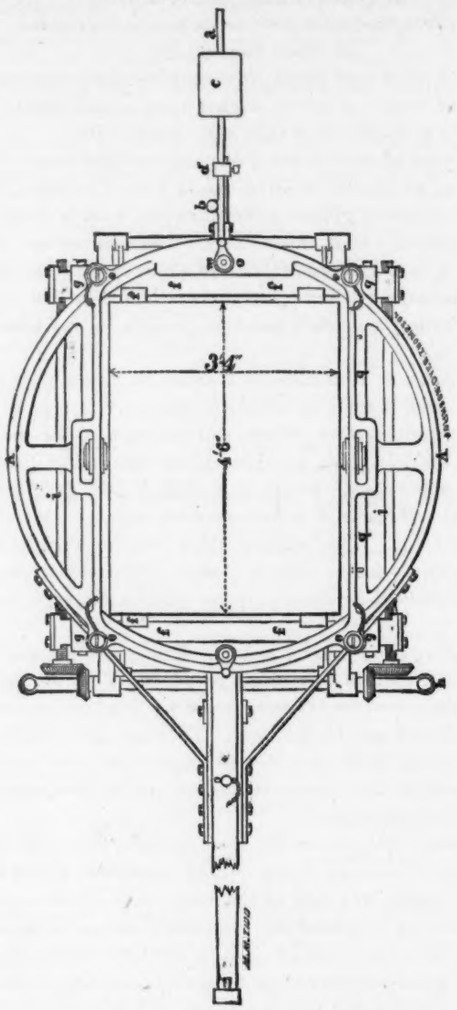
The best horse road-roller of which the writer has any cognizance is the one shown by the annexed drawings in plan, elevation, and in perspective.



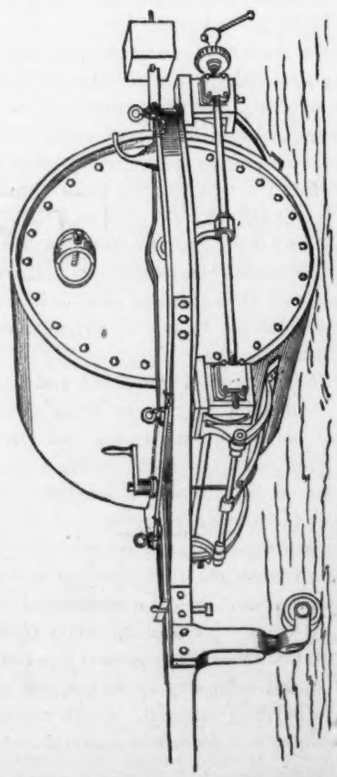
CIRCULAR FRAME HORSE ROAD-ROLLER.—*Elevation.*

(The town of Malden, Mass., has built a horse road-roller, according to the plan here described.)

It originates in Chemnitz, Germany, but can, of course be easily made by any machine-shop or foundry. The hollow roller is made of cast-iron, and is so arranged that it may be filled with water when it is to be used in heavy rolling; when not in use and about to be moved from place to place, the water is allowed to run out, thus materially lessening the load. A circular cast-iron frame A, surrounds the roller, and carries the axle bearings of the same. The outside of this frame is turned to form a groove in which a strong wrought-iron ring is fitted in such a manner that it will turn easily around the former. This wrought-iron ring consists of two semi-circular parts, at whose junction the pole is attached on one side, and on the other an extension bar, carrying the balance weight *c*, which may be shifted by means of the set clamp *d*, or turned up by means of the hinge *b*. Pins going through the holes at *e*, fasten this ring or allow it to be turned for the purpose of pulling the roller in the contrary direction, when required.



CIRCULAR FRAME HORSE ROAD-ROLLER.—*Plan.*



CIRCULAR FRAME HORSE ROAD-ROLLER.—*Perspective View.*

(*To be continued.*)

IMPROVED SEWERAGE FOR BOSTON.

The committee of the Boston City Council, to whom was referred the subject of an improved system of sewerage for that city, made a report to the Common Council last week, an abstract, at least, of which we hope to be able to lay before our readers in a short time. Scarcely anything had been heard of this important matter since the publication of the report and recommendations of Messrs. Chesbrough, Lane and Folsom, with the ensuing discussion, but a party of engineers has been quietly at work since that time, and the results of their surveys, borings, etc., are embodied in the report of the committee just made. It will be sufficient to state at present that the general scheme does not differ essentially from that proposed by Mr. Chesbrough and his associates, which we published in ENGINEERING NEWS, Vol. III pp. 148, 217; the principal deviation consists in substituting a tunnel of about a mile in length, straight across the mouth of the Neponset River, for the detour to the south which was then proposed. This tunnel would be about one hundred feet below the water level and would run for about one-half of its extent through clay which might require timbering, and for the other one-half of its length through conglomerate or pudding-stone, of a firm character, such as abounds in Roxbury and Dorchester. The pumping station at the westerly end of this tunnel would be somewhat to the north of the position indicated on the lithograph which we published.

The committee recommend the borrowing of $3,712,700, to constitute a special appropriation for the construction of an improved system of sewerage, and that they be authorized to undertake the work. They refer anew to the necessity which exists for the adoption of some plan and refer to former reports in place of giving arguments in detail. "In such matters, great reliance must be placed upon the opinions of persons who have made sanitary science a study, and, if the mass of testimony which has been presented from time to time be reviewed, it will be seen that the evils arising from defective sewers are discernible in this city to an alarming extent." "The plan for an improved system of sewerage which is now presented has the indorsement of the best engineering talent in the country. It is the result of a careful study of the different systems of sewerage now in practical operation, and an application of the best features of such systems to meet the present and future wants of Boston."

The opinion seems to prevail, among those best able to judge, that this projected and much needed improvement will be carried out.

ASPHALT paving is to be tried upon Columbus avenue, Boston, the wooden pavement which has been down some four or five years not proving satisfactory.

THE Woodruff Iron Works, at Hartford, Conn., proposed to make a mortar for Lake Superior smelting works, the casting to weigh 22,000 pounds, but the mould gave way when the iron was poured, and the attempt must be repeated.

A stranger, passing through Cleveland, Ohio, and taking the most cursory survey of the city, cannot fail to be struck with the great viaduct now under construction in the busiest part of the city. With the exception of an iron swing bridge of 332 feet span over the river giving two openings of about 150 feet each, the entire structure will be of masonry, and will connect at an elevation of between fifty and sixty feet, two portions of the city now separated by a valley or ravine. The work has been some three years under way and will probably occupy one and one half years more. There are ten nearly circular arches, eight of them having a span of 83 feet and a rise of about 33½ feet, while two are of 97½ feet span with the same rise as the others. The centre pier for the draw span is circular, 33 feet in diameter on the top, 40 feet on the bottom, four feet below the water line, and is carried upon 309 piles about 45 feet long.

The stones of the viaduct are laid by derricks, arranged in the most complete system we have ever seen, there being four to each arch, carried at the haunches, by independent framed supports from below, and braced by wire rope guys from one mast head to the others.

We have been promised, and hope to publish before long, a more particular account of this interesting construction.

The Engineer in charge of the work is Mr. S. H. Miller, formerly of the Atlantic & Great Western Railway.

WE consider the columns of "Proposals for Contracts" which we give weekly to be the leading specialty of our journal and the one which especially recomends it to business men. While a continually increasing subscription list attests the appreciation of this "specialty" we feel certain that the class of our readers to whom it is of particular interest hardly realize the labor and expense, together with the attendant difficulties of preparing these columns. In our last number,—of date July 14th,—there are contracts to be let for fifteen different pieces of work, in as many different places, situated in seven different states; to obtain those we had to examine several hundred papers, dailies and weeklies, the cost of which per year to any person would be several hundred dollars, besides the labor and time of examination; in getting those we threw aside three times as many more, as the short time for which they were advertised would expire before our paper would reach its readers; we set them up in a very expensive size of type for the sake of appearances and space, and usually give very nearly the whole advertisement that is officially furnished, giving up to this class of matter space that is weekly becoming more valuable. We have also spent a good deal of money in circulars and postage in search of Contracting intelligence besides the necessary clerical labor. There are the elements of cost which are easy to be figured by any reader. The difficulties to overcome are, to get early information of contracts to be let and have it conveyed to our readers in time to be of use. Every Contractor wants to know of work to be let, but he dislikes very much to have any other Contractor hear of it. Local County officers are more interested in local Contractors, generally, than in outside ones and the laws for advertising Contracts are almost universally adverse to finding the "lowest responsible bidder." Up to the present time, while there has been, among the Government Engineers, a disposition shown to send us early information of important works to be let, yet as a rule we get no assistance in this department, while not a few are disposed to find fault because we accomplish so little. We have before us at our present writing a list of eight good contracts cut from an Albany, N. Y. paper and kindly sent from the City Engineer's office, but the advertisements were inserted on the 13th to go in five times, so that they expire on the 17th while our paper is printed on the 20th, the date of the letting. If when the specifications had been drawn, we had been sent copies, with time of letting we could have given outsiders a chance.

Now, we are going to work this "specialty" of proposals until our office is recognized throughout the Union as the headquarters of Contracting intelligence; to do this requires money and time and facilities for obtaining and distributing information. If the present patrons of this journal will help us to the first and most necessary requirement by recommending our paper to their friends, and helping to extend our list of subscribers, we will in good time provide the other requirements for making this journal the vehicle of the most valuable business information that can be given to a large proportion of its readers.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

II.

Having complied with the legal requirements of the Act and passed his "preliminary" examination,—which is but a form—the would-be surveyor, as soon as possible indentures himself, to a Provincial Land Surveyor as an apprentice—or student, as he is usually styled. The term of service is three years, from date of the indenture (with the exceptions as given heretofore), and three months may be saved by having arrangements completed beforehand so as to sign the articles simultaneously with obtaining the certificate of preliminary examination. The terms upon which a student is accepted vary according to the real or professional standing of the surveyor applied to, and the gullibility or necessities of the applicant. Surveyors who are known to have an extensive practice, are always well supplied with students at liberal premiums; others who may not have a large actual practice, yet have sufficient to enable them to give occasional instruction in the field and office, and who have headquarters in a large town or city where students can enjoy themselves during the long months of idleness, that form the rule in the case of most surveyors' practice, can also add materially to their incomes from the premiums of students; obscure surveyors in small villages or resident in the country cannot always obtain premiums, but can occasionally hook a gudgeon who is so anxious to learn the whole art of land surveying that he will give his time free and pay his own board besides, thus furnishing the accommodating "master" with a cheap assistant, who, once indentured can be utilized either in surveying, farming, choring about the house, taking care of the horse, the cow, the pig, or the baby, or in a thousand and one ways can be made useful for three long years, at the end of which time he *may* know something about surveying, but if he has any brains at all he will *be certain* to have learned that he has been cheated out of at least two years of valuable time, and through much tribulation (principally of stomach) has earned an entrance to a profession that has neither the social standing nor the pecuniary emoluments which so great an expenditure of time, labor, and "fuss" entitles it to. A surveyor high in his profession has written—"Surveying, though in a certain sense simple, is in practice extremely difficult, requiring the highest kind of skilled labor. It is not a little dependent upon manual dexterity and general functional ability, which, practice apart, are a subtle product of individual organization. These are as necessary as the most perfect comprehension of method. A surveyor, if a good one, is an excellent compound of exercised natural qualities; and as the first instrument in surveying, I put him first. In thus speaking, I refer merely to the skilled workman, the day laborers, as it were, of geodesy. Where the higher branches of the science is reached, problems are afforded taxing the resources of the ablest mathematicians and astronomers." Surveying, from such a stand point as this means study, labor, the careful training of all the faculties of the mind and body, and it carries with it a compensation gratifying to a man's intellect if not always entirely satisfactory to his purse. But what is the ordinary practice of land surveying in the cedar swamps and pineries of the Dominion, on the prairies of the Western states, or hunting "old blazes" in the Eastern states that three full years of an intelligent man's time should be consumed in learning it?

How much time does it take to learn how to throw out a chain, to drag it through mud, and brambles, over fences, up hill and down, to count it, and then to tie it up, and carry it home? How much learning and time is necessary for an intelligent youth to learn how to take a vernier or a compass reading and record it; to become familiar with the adjustments of the ordinary surveying instruments or how to read an angle, either horizontal or vertical? Read section 9 of the Dominion Act as we have given it on page 175, *ante*, and if an apprentice has not already acquired the little information there made obligatory, how much of it will he be likely to get from his master during his term of service? Think of the geological acquirements of the average land surveyor, and what wonderful specimens of skill and accuracy are his "Plotting and Map Drawing." And after an intelligent man has seen a few farm boundaries run out according to the instructions, can he not read the Act as well as his master and interpret it as intelligently?

The practice of the Canadian student is almost entirely on surveys of Townships for the Government; "limit" lines for lumbermen, and farm boundaries for the farmers. In the cities there are occasional subdivisions to be made and building lines to be located, but this latter practice is the exception. Few surveyors outside of the cities have any office but their dining room; a plat is drawn on a sheet of foolscap, and all the education that is required is to calculate the area of the tract surveyed. A surveyor who averages one hundred days of practice in a year is doing well; the bal-

ance of the time a student puts in as best he can. The Board of Examiners never look into the question of practice, and if an applicant can only pass *their* examination, which does not necessitate more than a very rudimentary knowledge of surveying, they do not inquire into what his actual practice has been; but they do insist that the poor fellow shall live in the same town, if possible in the same house, with his master, for the full term of his apprenticeship, a very tyrranical and unnecessary requirement in the case of engineers, and surveyors from other provinces, who may wish to obtain the privilege of making legal surveys in any part of the Dominion, but who cannot spare the time nor inconveniences of actual residence with a Provincial Land Surveyor. But in "hair splitting" the Board can always take the medal.

Having passed my "preliminary," and complied with the requirements of Sec. 17 (p. 171, *ante*), I corresponded with several prominent surveyors on the subject of indentures, but not being able to agree on terms, I visited Ottawa City, which is the headquarters for a number of the best men in the profession on account of its being the Government headquarters and also that of the lumbering interests of the country. I found the fraternity there to be an off-hand, rough and ready, genial set of men generally, with abundance of idle time on their hands, offices well supplied with students, yet always room for one more at premiums varying from "my services free and pay all my own expenses" to the same privileges supplemented by £50 to £75 for the twelve months I had to serve. One surveyor did not care whether I knew a "cosine from a hole in the ground" if I could handle an axe, a paddle and birch canoe, or snow-shoe all day without tiring; another, whose office furniture consisted mostly of snow-shoes, hammocks, thump lines, and blankets, but who, having by a judicious matrimonial arrangement, got up "a corner" in government and limit work, seemed to be a desirable man to tie to, was willing to take £75 and allow me to put in my entire time *at home*, he agreeing to furnish the necessary certificates at the proper time. The terms were too liberal, so I returned home and shortly after indentured myself to my former class-mate, who had already obtained his diploma of P. L. S. and having hung out a shingle in a backwoods village on the Ottawa was anxious to have somebody with him with whom to discuss the rather dismal prospects for business, and so help to kill time. So I agreed to serve him faithfully for the space of one year as an apprentice, at my own expense for board and lodging whether at our hotel or while traveling; he to have all the revenue from my services during the year, and in return therefor was to give me the benefit of all his practice and of his knowledge of the abstruse science of land surveying. This arrangement was considered a very liberal one on his part then, and would be equally so to-day any where in the Dominion.

THE JAPAN LIGHTS.*

BY RICHARD HENRY BRUNTON, M. INST. C. E.

(*Continued from page 180.*)

The various lighthouses were constructed of stone or brick, wood or iron, as found most suitable for the locality. They are generally circular at the base, and the walls have a straight batter on the outside and are plumb on the inside. Forming a semicircle round the bases are two store-rooms, one for oil, and the other for dry stores. Paint, fuel, and additional store-rooms are erected in the grounds. The lightkeepers' dwellings are of stone or brick, and contain from six to eight rooms: the kitchens and outhouses are in separate buildings. The grounds are surrounded by a stout fence or wall, about 8 feet high.

The stone lighthouses have all been constructed of ashlar masonry. Most of the stone employed was granite, of excellent quality. In some cases a volcanic claystone, of a greyish appearance, and of a tough hard character, has been used; but there are evidences of slight deterioration in this stone on the exposed surfaces. The courses have, in all cases, been 12 inches thick; and headers, from 4 feet to 2 feet wide, have been put through the walls at every third or fifth course. The stretchers are also of large size, there being, in most cases, not more than two in the thickness of the walls.

The brick lighthouses are amongst the latest erected. The making of bricks in Japan has only been recently introduced, and their manufacture has not yet obtained such perfection as to warrant their adoption where any other material is procurable. All the bricks were specially made by men employed by the Department for the purpose. The bricks were generally well formed, and of good reliable clay; but the native workmen were negligent in the process of burning, and the bricks suffered in consequence. Every precaution was taken to reject faulty ones. Those which were used resisted a pressure of 700 lbs. on the square inch. Their porosity, however, was considerably greater than was desirable, as they absorbed from 10 to 12 per cent. of their weight of water. In order to render their liability to deterioration as slight as possible, the outsides of all brick towers have been coated with Portland-cement plaster. "Flemish" bond was adopted, and hoop-iron bond was inserted between every fifth course. The lintels, soles, and rabbets of the doors and windows are all of stone. For about 13 inches from the face of the walls the courses were jointed by Portland-cement mortar, the remainder being laid in lime mortar.

Special precautions were taken regarding the lime supplied for the works. The Japanese were formerly ignorant of the use or properties of lime mortar; and although limestone was burned by them for purposes of their own, their custom was to keep it, after it had been slaked, in straw bags for indefinite periods, and to sell it in this state. They had never adopted the system of mixing it with sand, and using it as a bed for stones, the principal use to which it was put being as plaster, when it was mixed with boiled seaweed. At most of the lighthouse works lime-kilns were erected, and the limestone burned on the spot. The lime was generally pure, and good mortar was formed by mixing 1 part of it with from 3 to five parts of sand.

The wood adopted for the main beams, uprights, etc., of those lighthouses which were built of timber is a native production named "keaki" (*Planera Japonica*). It is hard, only a little lighter than water, with a close grain, and when of good quality of an endurable nature. But it is difficult to procure a good keaki, owing to the absence of restrictions in the felling of timber. Much of the wood offered for sale is unripe or full of sap, and little is to be found which has undergone seasoning, to which process but small attention is paid by the natives. Keaki is the only hard wood grown in the country in sufficient quantity to be available for building. The favorite soft wood, for floors, linings, doors, and windows, etc., is called "shinoki" (*Chamæcyparis obtusa*). It has a beautiful white grain, and is very lasting. The other woods employed in the lighthouses are "sugi," a species of cedar (*Cryptomeria Japonica*) and "matsu," a kind of pine (*Pinus Densiflora*). These are considered inferior, and decay quickly when exposed to the weather. They, however, are durable when kept dry, and have been used for the trusses of roofs and for floor-joists, etc. Most of the wooden lighthouses are octagonal at the base, the eight uprights, at the angles, resting upon square blocks of stone, founded in the earth. There is also a centre upright, from which horizontal beams radiate towards the eight outer uprights. Between these latter there are diagonal beams, crossing each other, and horizontal beams at the top of the diagonals. The beams are all secured by iron straps and bolts. The drawings for these towers were made after designs furnished by Messrs. D. and T. Stevenson. The scantlings of the timbers are greater than would have been necessary with the ordinary hard woods used in England, although it is generally believed that keaki would compare favorably with any of them in point of strength.

All iron used in Japan up to the present time has been imported from Europe, and structures formed of it are necessarily costly. Three lighthouses only have, on this account, been made of iron, and then it was adopted on account of the inaccessibility of their sites. It was found that the different parts of the lighthouse, when of iron, were more easily handled, and, after they had been fitted in their places, were more rapidly put together, than if any other material was employed. These iron towers are from 20 to 30 feet high, and are entirely cased with ¼ and 3-16th inch plate, riveted to the beams. They are constructed with eight or more girder uprights, consisting of two angle irons, 3 inches by 3 inches by ½ inch, and a web and flange of ⅜-inch plate, 12 inches wide. These support the girder beams of the different floors, as well as the lantern and apparatus. Small uprights at the angles of the towers rest upon a wrought-iron sole-plate bedded on a stone foundation. One iron screw pile lighthouse, erected at Haneda, was designed by Messrs. Stevenson, constructed in England, and sent to Japan in pieces.

There were unusual difficulties in the construction of some of the lighthouses. For instance, Mikomoto, or Rock Island Lighthouse, has been erected on an isolated rock about 2,000 feet long by 450 feet wide, by 100 feet high, at its summit. It is situated off the harbor of Shimoda, about 80 miles south-west of Yokohama, and at a distance of 6 miles from the nearest land. All vessels on their way to Yokohama from the south pass this rock; and, as there are rocks between it and the shore, it is an extremely dangerous locality, and an important position for a light. The sides of the island are precipitous, and in heavy gales of wind green seas dash right over it. It is composed of a hard, brittle, igneous rock, worn to sharp points by the weather. The currents which run with great velocity in the neighborhood, cause a constant turbulence in the sea, and it is, further, subject to frequent gales. The locality is also believed to have suffered severely from the earthquake shocks. From the exposed position of the rock the construction of this lighthouse was a work of difficulty. At Shimoda a hard clay-stone was found, and a quarry was opened for the works. Limestone was discovered in close proximity, and a kiln was erected on the rock, where the stone was burned. It yielded an excellent lime. Communication with the rock was carried on by native-built boats, worked by the natives with extraordinary skill. The lighthouse is of stone, 58 feet high to the sole-plate of the lantern. It is in the shape of a truncated cone, and is surmounted by a capital having twenty-four Gothic arched recesses round it. The diameter at the base is 22 feet and at the top 16 feet. The thickness of the walls at the base is 6 feet and at the top 3 feet. It is fitted with a spiral staircase of keaki. The light shows all round the horizon, and a red ray of 55° is inserted, which covers all dangers between it and the shore. The work of cutting away the rock to prepare for the foundations of the tower was commenced in April, 1869, and the lighthouse was first illuminated on the 1st of January, 1871.

Yebosishima is a conical rock 60 milrs to the southwestward of Shimonoseki Straits and 10 miles off the mainland. It is passed by all vessels proceeding between the Inland Sea and Nagasaki. The Island is 120 feet high, and is composed of hard basalt. Its sides are precipitous. Immense boulders, weighing upwards of 50 tons each, were found on its summit, and these had to be removed before sufficient space could be obtained for the buildings. Owing to the inaccessibility of the site an iron tower was erected. It is octagonal, 32 feet 6 inches high, and the extreme width is 23 feet 6 inches at the bottom, and 18 feet 6 inches at the top. A stone dwelling house and a water and paint store were erected on the rock. Winding steps were cut in the face of the rock, and a tramway was laid by which the materials were conveyed to the summit. The materials were brought, as at Rock Island, in native boats, and were lifted out by shear legs, made to project over the boats, and these could only lie at some distance off. No landing could be effected unless the water was quite smooth, and progress was on this account much delayed. The works were commenced in August 1873, and the light was first exhibited on the 1st of August, 1875. A relief station has been established at the nearest point of the mainland, on one of the headlands at the entrance to Yobuko harbor. Two Lightkeepers alternately live here, leaving three on watch at Yebosi, and a system of signals arranged between the relief station and the lighthouse.

Satanomisaki (Chichakoff), the most southerly point of Japan, is the headland which vessels coming from the China seas generally make first. The headland is lofty and precipitous, and is covered with thick brushwood; but no site could be found on it for a lighthouse to serve all the intended purposes. Directly off the point, however, there are two small islands, the outside

*Paper read before the Institution of Civil Engineers, London.

one of which is about 300 yards distant from the mainland and 180 feet high. The point is exposed to the full strength of the Japan stream, which not unfrequently attains a speed of 3 or 4 miles an hour. This causes a constant disturbance in the sea, and between the outside island and the mainland there is generally a boiling surge. The island is pinnacle-shaped, and its summit had to be lowered for nearly 40 feet, before sufficient space could be obtained for the lighthouse tower. The dwellings for the lighthouse keepers were erected on the mainland. Owing to the disturbance in the sea caused by the currents, communication between the dwellings and the lighthouse was difficult. A wire rope was originally stretched across, first to the middle island and thence to the lighthouse, along which a cage was propelled by friction pulleys worked by a handle in the cage. This was used as means of transport for men and materials for several years, but owing to a disinclination of the lightkeepers to use it, caused by nervousness from being suspended at so great a height, it was eventually abandoned. Communication is now carried on by boats, when the water is sufficiently smooth to enable a landing to be made. The tower is of iron, and is 17 feet 9 inches high to the sole-plate of the lantern. It is hexagonal, 24 feet in extreme width at its base and 16 feet at its summit. The lower floor of the tower is set apart as a sleeping and living room for the lightkeepers stationed on the rock, and space is also provided to enable them to keep sufficient provisions to last until relief arrives from the mainland. The other floor of the tower is used for the purposes of the light.

The highest lighthouses are the brick lighthouse at Noshima, 85 feet high to the sole-plate of the lantern; the brick lighthouse at Inuboye, 80 feet high to the sole-plate of the iron parapet; the brick lighthouse at Siriyasaki, 82 feet 6 inches high to the sole-plate of the iron parapet; the wooden lighthouse at Shiwomisaki, 61 feet high to the sole of the lantern; and the stone lighthouse at Kadoshima, 74 feet 7 inches high to the sole of the iron parapet.

The lightships were built, under the superintendence of the author, by native workmen. They are 70 feet 8 inches long between the perpendiculars, 18 feet 10 inches breadth of beam, 9 feet 2 inches from the deck to the top of the limbers, and are 130 tons burthen by builders' measurement. They are fitted with two decks, having a clear highway of 6 feet 6 inches between them. The lower one, running the whole length of the ship, is used as a berth-deck for the accommodation of the captain and crew. Below are the water-tanks, cable-lockers, ballast-space, fuel and lumber stores. The keel, stern-post, stem, timbers, etc., are of keaki. The outside planking is also of keaki, 2 inches thick. The upper deck is of shinoki, 2½ inches thick; and the lower deck of sugi, or cedar, 2 inches thick. The vessels are fastened with ¾-inch copper bolts, and are sheathed with Muntz metal weighing 26 oz. to the superficial foot, up to 2 feet above the water-line. They have two masts. The lantern, containing the light apparatus, is hoisted on the mainmast, which is 16 inches in diameter, and 40 feet high. They are flat on the floors, and are made with a bow specially adopted for riding in a heavy sea after the model of the Trinity light-vessels. They are moored with two 30-cwt. anchors having 60 fathoms of 1½-inch standard cable on each.

The beacons, built on rocks only awash at low water, are constructed of solid ashlar masonry, the stones in each course being made to radiate from the centre. They are 8 feet in diameter at the base, and 4 feet at the summit the height being 20 feet. In the first six courses the stones are secured by hard wood joggles; and the coping stones, or the balls which surmount the structure are secured by a 2-inch bolt, which goes through 7 feet of the masonry.

The buoys were constructed of iron, likewise from the designs of the author, by native workmen. They are of the ordinary shapes of nun, can, and hollow-bottomed buoys. Their moorings consist of two lengths, of from 15 to 30 fathoms, of ¾-inch cable, attached to two 5-cwt. anchors, one being placed up, and the other down stream. The anchors made by Japanese workmen are very efficient.

The glass-work of the apparatus for the different lights has been manufactured from the designs of Messrs. D. and T. Stevenson, by Messrs. Chance Brothers, Birmingham; Messrs. Sautter, Lemonier and Co., and Messrs. Barbier and Fenestre, Paris. The lanterns, machines, reflectors, reflector-frames, etc., have been principally executed by Messrs. Milne and Son, and Messrs. Dove and Co., of Edinburgh.

Besides the aseismatic tables in the first lighthouses, the Messrs. Stevenson were induced to adopt a species of apparatus of as unfragile a nature as possible. They had fears that the sudden shocks, to which the lighthouses would be exposed, might derange the delicate glass-work in a dioptric apparatus, and they consequently decided to use metallic reflectors. They are arranged on frames secured to the aseismatic tables, and they are supplied for all the lights included in the original order. In addition to this, the lanterns were made as low as possible, and of an increased strength. The daylight height of these is 6 feet only; whereas the ordinary height of first order lanterns is 9 feet 9 inches.

While there can be little doubt that these measures tend to lessen the risk of fracture or derangement from earthquakes; and while the use of reflectors offers this additional advantage, that in case of the partial destruction of the apparatus, the light can be at once reinstated by keeping in stock a few spare reflectors, lamps, etc., other considerations render the adoption of these a matter of doubtful expediency. The whole country is subject to severe earthquakes; but that any single lighthouse should experience a shock of such severity as would derange its optical apparatus, is a remote contingency, and not likely to occur more than once in a century. It may further be assumed, that such a shock as would fracture an apparatus would, in all probability, prove destructive to the lighthouse tower in which it was placed. After the occurrence of such an earthquake, therefore, the permanent light must necessarily be extinguished until steps were taken to replace both the tower and the apparatus, and the accomplishment of this would, under any circumstances, occupy some time.

(To be continued.)

MODERN WITCHCRAFT.

One might suppose, in view of the vast movement of humanity always going on from west to east and from north to south, that the majority of mankind get into a way of thinking, every little while, that any place is better than home, and that the height of happiness is getting away from home; for it is amazing to see the masses of humanity that are forever on the wing. But of course there is no ground for such a supposition. People, as a rule, love their homes, and are on the wing in order to keep their homes, to help them, or improve them, or to enjoy them better; and all that the movement implies is a great vitality in the race, and the resulting healthiness and vigor which always accompany free circulation.

One cannot but conjecture concerning the good effect that all this amount of travel must have on the general mind in the acquaintance that it gives, not with distant lands merely, but with regions not far removed from our own, yet with which we were till yesterday as utterly unfamiliar as with the ends of the earth, acquaintance with their people, and with human nature in general. The traveler becomes a cosmopolitan; for the enlargement of the mind can not fail to destroy prejudice, create toleration, and, in causing one to feel a thousand times more friendly and forbearing to the rest of the species and their abiding-places, to make one a citizen of the world.

It is, then, a subject of mutual congratulation among us that traveling has been made so easy and put within the reach of so many. The woman who, in old times, would not twice in a lifetime have gone beyond the boundary of her native village, and would have remained ignorant of the world and its ways, has now only to pack her-hand bag, and in the time in which she would once have gotten ready for the laborious stage-coach journey of fifty miles, and at a less expense and fatigue, is whirled into meridians and among people that supply to her the place of a liberal education, that give her something beyond the range of household gossip to talk about, that give also other and larger views of life, and that make herself feel a part of the great march of the race, and not, as she has done in her ignorant seclusion, like an atom of dust under its feet.

The way in which modern travel conquers both space and time is something marvelous: and yet we doubt if we have reached anything more than a prophecy of what is yet to be achieved—whether space is to be annihilated by projectile saloons shot from vast mortars, by cushioned and illuminated ones flying through the grooves of pneumatic tubes, by ascensions into upper ether, and delays there till the desired spot of the world rolls round, and then the doomed pounce of the fish-hawk on its prey, or any thing yet more beyond seeming bounds of possibility.

But till these further wonders are accomplished, those of steam, as at present conducted, are sufficient for our admiration. As you sit in your easy chair in a palace-car, and see the panorama of mountain and river and city unroll before you, all sorts of stories of old magic rise in your memory, from the crystal of CORNELIUS AGRIPPA, in which one saw the absent and the distant, to the flying carpet and brazen horse and broad-winged afrite, and the Arabian Nights seem suddenly to have become real and true. As you fall asleep, comfortably pillowed and curtained away, with the stars shining outside your window, and wake to find the sun up, and mountain range and river and whole States traversed, even the Arabian Nights themselves are exceeded. When you wake in the night and hear the workmen beneath the train tapping and sounding the wheels, you are not only impressed with all the vividness in which things present themselves in the night and darkness, with the tremendous conquests of man over nature, but with a keener sense of a protecting Providence than almost anything else can give you. Rolling and tossing for weeks together on the sea prepare you for your destination day by day, but railroad travel, with its swift changes of horizon, brings about actual results so quickly that it seems less like something attained by our own effort than by the effect of wizardy occult sciences.

But there is another wizardy about travel, and one that has almost as much to do with its swiftness and ease as steam itself; and that is the witchcraft of good nature as fatigue sets in. "A merry heart goes all the day, your sad tires in a mile-a," sang the rogue Autolycus, and the saying is nowhere truer than in the railway car.

Begin to fret, to worry and fidget, to notice the heat, the dust, the cinders, the jar; to revile the road and the car and the rate of running, the scenery, the people, the air; to feel the disagreeableness of too close contact; to be disturbed by this one's window, which is up, and that one's, which is down; to deride the eating-houses on the way, to fuss with the bundles, to fume about the baggage, to have cold chills at the thought of losing a connection, and colder ones with the fear of a disaster—all that, so far from annihilating time and space, prolongs every moment of the one, and wearies you as much as through you yourself were dragging the train through the other, and not only for your part of it all, but for that of every one else around you. Suppose the train does jolt; could you go so fast in any other way? Suppose the engine does shed cinders; have you invented anything better? Suppose there is dust on the way; will the price you pay for your ticket afford water-sprinklers to hundreds of miles of the route? Suppose that people crowd too near you; have they not the same right as yourself, and may they not be equally disdainful of your approach? The only way to enjoy yourself in travel is, having once chosen your route and embarked, to leave the rest to fate. If the luggage has gone astray, worrying will not bring it back; if the connection cannot be made, it cannot; if there is to be an accident, there will be, and you, at any rate, could not in no way hinder it; and it is about as wise to revile the weather, which no mortal power can change, as to revile the road or any of its concomitants. As far as that road is concerned, your bed is made, and you must lie in it; to make yourself uneasy about it is a waste of vital force, in which it always amazes us to see any sensible person indulge. "I am not a very good traveler," said a lady in whose company we once took a long journey of over two thousand miles; "I always get a headache and forget my parcels." But it had struck us that of all travelers she was the model one.

The parcels that she forgot were trifles; she allowed her headache to trouble nobody; and through all the

hundred hours of fatigue she was never once heard to complain. Never once heard to complain; that is the secret of pleasant travel; and the old lady who, when the train jumped the track into wreck and ruin, smilingly answered the person who extricated her with the assurance that she thought they always stopped so, was only an exaggerated example of the behavior that adds the last touch to the magic of modern travel.—*Harper's Bazar.*

SPECIFICATIONS

FOR MACHINERY TO BE USED IN THE OPERATION OF THE FULLERTON AVE. CONDUIT, CHICAGO, ILL.

The Contractor is to deliver, and erect, in an Engine House, upon foundations to be provided by the City of Chicago, each in its respective place, all the parts of the machinery forming the subject of these specifications. Said machinery is to consist of two vertical, direct-acting, single cylinder, condensing engines, with shaft, screws, and boilers, complete in all their parts, connections, and appurtenances, necessary to operate said screws under the conditions hereinafter stated. The Engine House is to be situated upon such lot, fronting on or near Fullerton Avenue and the North Branch of the Chicago River, as the City of Chicago may procure for the purpose.

The specifications for the machinery are not intended to be complete in matters of detail, but only to indicate the power required in the engines and boilers, the quality of the material and workmanship, an outline of the general parts and form, the requirements necessary to adapt them to their particular service and location, and the amount, and economy of work, which the engines and boilers will be called upon to perform.

CHAMBER.

The engines are to be coupled at right angles to a horizontal shaft, which shaft is to be located in a water-tight chamber, and in the line of the centre of Fullerton Avenue Conduit. The shaft is to extend through each end of the chamber into the Conduit, and upon each projecting end of the shaft, a screw is to be secured, in a manner hereinafter described.

The water-tight iron chamber, in conformity to which parts of the machinery are to be designed and constructed, will be built by the City previous to the time the contractor is required to place said machinery; but the following general description is given as a guide to the contractor in maturing his design and making his proposal.

The Chamber is to be 38 feet in extreme length—but the available inside length will be 23 feet—19 feet in depth, and 10 feet in extreme width at the middle. It will be constructed of wrought and cast iron, the bottom of cast iron plates ribbed and flanged, resting on stone masonry and securely bolted to the same. Each end of the chamber to be a single casting, extending from 3 feet below, to 9 feet above, the bottom of the chamber, and to be 7½ feet wide in the direction of the length of the shaft. Through this casting, concentric with the shaft, will be cylindrical openings 11 inches in diameter and 7½ feet in length. This opening will be bored, while in place, by the contractor, true to the line of the shaft and is to receive the stuffing box and end bearing of the shaft.

The sides, and ends of the chamber above the end castings, are to be of boiler plate, stiffened with vertical [T] irons, and one horizontal cast iron rib on each side.

Six posts of angle and plate irons will stand in the centre portion of the chamber, riveted to girders spanning the top, and to the cast iron bottom plates, and braced to the side ribs as shown. These iron posts are to take the reaction of the force exerted by the engines. The total distance from the centre of the shaft to the top of the girders is to be sixteen feet. The bed plate of the engines are to rest upon, and be secured to, the cross girders at the top of the chamber.

The air pumps and condensers to be situated inside the chamber at any point to suit the convenience of the design.

The engines are to be exact duplicates in all their parts.

CYLINDERS.

Each cylinder to be twenty [20] inches in diameter, and of sufficient length (with as small space for clearance as possible) to allow the stroke of the piston to be thirty [30] inches. To be made of the best closed grained cast iron, as hard as can be bored.

Both cylinders are to be covered with the most approved non-conducting composition, leaving an air space of three-quarters [¾] of an inch between the covering and the surface of the cylinder. Outside of the covering a casing of black walnut to be put on edgewise and secured by dowels through the sides.

VALVES.

The steam valves shall be such as will give a quick cut off at any portion of the stroke, from one-eighth [⅛] length of stroke, to full stroke, and which may be easily regulated to close at any point between these limits, while the engine is in motion.

AIR PUMPS.

There is to be an air pump for each engine. Each pump to be single acting, and the space swept through by the piston per stroke to be one and one-half [1½] cubic feet. To have India rubber disc valves seated on brass, for the foot and bucket valves, and an iron disc, with rubber face, commonly called a floating top, for a delivery valve.

The air pumps to discharge into a cistern, or hot well, from which the surplus water, not required for feeding the boilers, is to discharge into the conduit through a suitable pipe.

CONDENSERS.

There is to be one condenser for each engine, with a capacity of at least five times that of the air pump. The condenser to be located at some convenient place in the shaft chamber, and properly connected with the exhaust valves of the engine, and with the air pump. To be supplied with condensing water through a perforated annular pipe surrounding the top of the condenser.

HAND GEAR.

The engines to be provided with full and complete hand gear, placing the engine, injection valves, etc., perfectly under the control of the engineer on the floor of the engine house, and also with the necessary gear to permit them to be reversed and run either way.

INDICATOR GEAR.

A full set of indicator gear is to be provided by the contractor, including steam and vacuum gauges, Richards' indicator, and counter, one of each for each engine. A full set of new wrenches and such other tools as may be necessary for use in the operation of the engines, to be furnished by the contractor, and the machinery is to be fully and properly supplied with brass oil cups of the most approved pattern, placed at all the lubricating points, also with drip pans to receive the waste oil, and all necessary waste and dry cocks.

SHAFT.

The shaft is to be of the best hammered wrought iron. It is to be long enough to extend through the shaft chamber from end to end, and sufficiently beyond to furnish room to secure the screws. To be eight [8] inches in diameter and to be made in three [3] sections.

The middle or crank section, to which the engines are coupled, and which is to carry the eccentrics for working the valves, to be supported upon three pillow blocks properly fitted with composition bearings throughout. The shaft to be loaded on the side opposite the crank pins so as to perfectly counterbalance the pistons and connecting rods and the eccentrics and eccentric rods.

The end sections are to be duplicates of each other, each section properly supplied with an independent plummer, or thrust block, to receive the thrust of the screw, a stuffing box, and an outside bearing of phosphor bronze three (3) feet in length, securely fitted into the cylindrical opening in the end casting of the chamber, in such manner as to afford a thorough lubrication by water. The plummer block is to be adjustable, and is to be so adjusted as to prevent any of the thrust and wear from the screw coming upon the end post of the shaft chamber.

The end sections of the shaft to be connected with the middle section by couplings, which can be readily disengaged, and which are to have a longitudinal play sufficient to prevent the thrust from the end sections being communicated to the middle section.

SCREWS.

There are to be two screws made of the best cast iron; each screw to be four [4] bladed, and six [6] feet seven [7] inches in diameter, made with a pitch of eight [8] feet.

The back and forward edges of the screw blades when projected upon a plane parallel to the axis, to be parallel one to another, and the blades as forshortened in projection to be twelve [12] inches in width, making the total area of the four [4] screw blades of each screw one half [½] of the total area of a complete turn of the helicoid. Each surface of the blades to be smoothly dressed to the true helicoidal surface, except in the slight variation from the true helicoid occasioned by making the blades with feather edges, and by their being thicker at the hub than at the periphery. The blades are to have a thickness of two [2] inches at the hub, and three-quarters [¾] of an inch at the periphery. The hub to be fourteen [14] inches in the axial length, and twelve [12] inches in outside diameter.

The screws to be secured to the shaft by means of steel keys and bolts passing through the hub.

On the end of the shaft projecting through the hub a conical cap is to be secured.

BOILERS.

There are to be three tubular boilers, set in masonry, with longitudinal, return flues. Shells, cylindrical, and sixty-six [66] inches in diameter and sixteen [16] feet in length. Each boiler to have forty [40] five [5] inch tubes. The flues and all portions are to be made with special reference to burning bituminous coal, and the prevention of smoke. They shall also be capable of burning anthracite to good advantage.

The furnace under each boiler to have thirty [30] square feet of grate surface.

The boilers to be set by the contractor in the very best manner, and with the best materials, so as to give one thousand [1000] square feet of available heating surface. In estimating the heating surface, only that portion of the shell and the tubes which have common contact with the water and the fire is to be considered available heating surface. Each boiler to be set singly and its flues connected with the chimney and furnished with all dampers necessary to control the draft.

Each boiler, and furnace, to be furnished with steam dome, furnace plate, grate bars and bearers, connection doors, manholes, and hand holes, wall binders, stop, safety and blow-off valves, check valve, steam and glass water gauge and gauge cocks, and all details necessary to make them complete and perfect in every respect.

The boilers are to be made strong enough to bear a constant pressure of eighty [80] pounds per square inch above the atmosphere, and shall be double riveted on all transverse seams.

They shall be tested with a hydraulic pressure of one hundred and twenty [120] pounds per square inch, and are to conform to the U. S. Government rules and regulations in relation to boilers of this class. The contractor is to furnish an independent steam feed pump of an approved make, provided with all the necessary piping, cocks, valves, etc., to connect it with the hot well of the engines, and also with the Conduit and the boilers. He is also to furnish and put in place steam pipes connecting the boilers with the engines, and is to carefully protect them from loss of heat by a thorough coating of the most approved non-conducting material.

That portion of the shell of the boilers immediately in contact with the hottest portion of the flame to be made of S. F. B. iron, and all other portions of the shell of C. H. No. 1 Shell iron. A full set of fire tools to be furnished by the contractor.

STAIRWAY AND RAILING.

A spiral iron stairway is to be built by the contractor in one end of the chamber leading from the floor of the engine room to the bottom of the shaft chamber.

The stairway is to be surmounted with a sufficiently strong hand rail, passing through wrought iron stanchions.

All the space at the top of the shaft chamber, not of necessity occupied by the bed plates of the engines and platform, to be left open and surrounded by wrought iron stanchions, and a sufficiently strong hand rail of brass.

DRAWINGS.

The contractor is, without extra charge, to furnish all the drawings, except those accompanying these specifications, and on completion of the work, is to furnish the Department of Public Works, with a full and complete set of drawings in detail, of the machinery as constructed, with the dimensions marked thereon, and drawn to such scale as to admit of binding in convenient form.

The contractor is to accompany his proposal with general specifications of the main features of the details which he proposes to adopt in the construction of the engines and boilers; and before work is commenced, he is to submit to the Department of Public Works, for inspection, the proportions, forms and kinds of material to be used, as shown in detail drawings.

DUTY.

The duty required is to be seventy [70] millions foot pounds per hundred [100] pounds of coal consumed, with a boiler pressure of sixty [60] pounds per square inch above the atmosphere, when the engines are making one hundred [100] revolutions per minute. It is to be calculated upon the gross work done by the engines in foot pounds, less the work of overcoming the friction of the moving parts in foot pounds during a given time, and the coal consumed during the same time.

The duty is to be ascertained by the Department of Public Works, and by means either of indicators or dynamometors, or both, at the option of said Department, and the duty so ascertained is to be taken as a basis for a final settlement between the contractor and the City of Chicago.

MISCELLANEOUS.

The piston rods, connecting rods, air pump rods, etc. shall be made of the best hammered wrought iron.

There shall be no unnecessary amount of bright finished parts to the engines, and all parts left unfinished to be painted with two coats of lead, brought to any desirable shade.

The engines are to work with steadiness, regularity and smoothness, and are to be capable of making as many as 125 revolutions per minute, and no material, mechanical device, or movement is to be used in their construction which is unsuitable for this high speed.

The machinery is to be completed and put into operation by the contractor before the first day of November, 1877, and the contractor is to select and pay one engineer and two assistants who shall be satisfactory to the Department of Public Works, to operate the machinery for a period of twelve [12] months. The other expenses of operation to be paid by the City.

From time to time during the construction of the machinery, estimates will be made of the value of the finished work, and vouchers issued to the contractor to the amount of seventy-five [75] per cent. of such estimated value. Vouchers will be issued only upon finished work, and that only, when delivered upon the grounds of the engine house, unless satisfactory evidence is given to the Department of Public Works, that the work is secure against all debts, or obligations, of whatever nature of the contractor.

At some suitable time during the twelve months that the engines are to be operated by the contractor, their duty shall be ascertained by the Department of Public Works, as heretofore specified, and if it is found that

they fulfill the requirements of the specifications, both as to duty, and quality of material and workmanship, they are to be accepted by the Department of Public Works, and vouchers are to be issued to the contractor, which, in addition to those previously issued are to amount to ninety [90] per cent. of this contract; the remaining ten [10] per cent. being reserved until the expiration of the time during which the contractor is to operate the engines. But if the engines fail to perform the duty required by the specifications, then a deduction of three hundred [300] dollars will be made from the contract price for each one million [1,000,000] foot pounds of duty which the trial duty shall be less than the duty required by the specifications, and vouchers will be issued as above stated with the reduced price as a basis.

If for any cause the city should fail to have the necessary building completed, or in such state of completion, as to admit of the contractor's fulfilling his part of the contract in regard to time, then the city shall pay the contractor interest at the rate of ten [10] per cent. per annum upon the amount retained, and for the length of time such amount is retained, longer than it otherwise would have been, but for the failure to provide such buildings and foundations in due time.

All the material used, and workmanship performed, shall be the best of its kind, considered with reference to the purpose to which it is to be put, and the place in which it is to be employed. All material and workmanship, both in the shops, and on the ground where the machinery is to be erected, is to be subjected to inspection by the Department of Public Works, and all imperfect, or unsuitable material, and all unfaithful or inaccurate workmanship is to be rejected, and in case of a failure from any of the above named causes, or any part of the machinery or any part of the structure built by the contractor within the period during which he is to operate the machinery, the contractor, shall at his own expense, remove the defective part or parts and replace them with sound and acceptable work, or put the same in perfect repair.

In case any part, or parts, of the machinery, or device used by the contractor in connection with the machinery, or any part thereof, shall have been patented, then the contractor shall, at his own expense, procure the right to use the same, and transfer the right to the City of Chicago; and the contractor is to protect said City from all claims or demands of any person or persons whosoever, on account of any patent.

CORRESPONDENCE.

WASHINGTON, D. C. *July, 2, 1877.*

Editor ENGINEERING NEWS:

SIR:—In the issue of June 23d., your correspondent evidently refers to me and the Nautrigon. A careful review of my description of that instrument has failed to convince me that it contains the errors or "erroneous representation" which he assumes to expose.

As the compass card of the instrument, upon which the azimuth must be read, is necessarily small and therefore incapable of giving results with much greater accuracy than required for correcting the ship's compass for magnetic variation, it is of altogether secondary importance and I alluded to it but briefly. I might have been more explicit and stated that, for convenience, the card was placed at the declination pin, and that to use it for azimuth at the ship's position, the declination and latitude circles should be for the time transposed, the declination pin being set at the latitude of the ship. The altitude and the latitude arcs are then to be brought to intersect at the *declination* and *altitude* of the object.

Further it is not plain that your correspondent's suggestion concerning the altitude arc, points out a practicable improvement. I have found it convenient on many occasions to be able to read a leveling staff wrong end up (the staff I mean) especially when employing an inexperienced rodman.

BERNARD R. GREEN.

CLEVELAND, *July 9, 1877.*

Editor ENGINEERING NEWS:

SIR:—The following data may suggest new thoughts to those of our profession who make a study of Field work. I offer them without modification or deduction, just as copied from my Field Book, under date of January 15, 1877.

Distance between the zero points of two fixed verniers, as determined by four new steel tapes, Chesterman's patent, without joint, under strains varying from 1 to 24 pounds.

Strain.	Tape 1.	Tape 2.	Tape 3.	Tape 4.
1 pound.	49.503 ft.	49.506 ft.	49.503 ft.	(?)
2 "	49.501 "	49.505 "	49.502 "	49.503 ft.
4 "	49.500 "	49.503 "	49.500 "	49.502 "
6 "	49.499 "	49.502 "	49.499 "	49.500 "
10 "	49.496 "	49.500 "	49.496 "	49.497 "
15 "	49.491 "	49.496 "	49.492 "	49.493 "
20 "	49.487 "	49.492 "	49.487 "	49.489 "
24 "	49.484 "	49.489 "	49.486 "	49.487 "

The tapes were resting throughout their full length during the experiment; two observers took the readings from the verniers at the same inst, while a third noted the strain upon the spring balance. The balance was attached to the ring end of the tape, thus making a subtraction necessary to obtain the data above given.

C. H. B.

PHILADELPHIA, *July 9, 1877.*

Editor ENGINEERING NEWS:

SIR.—Your correspondent, a "Subscriber," wishes to know "the most judicious proportions for the opening of a culvert." The following solution may prove interesting:

Let S = the span of the opening.
Let h = the height of the opening.
Let b = the height of the bank on top of the culvert.
Let t = the thickness of the covering stone.
Let a = the area of the water way = S h = a constant.

If the walls are proportioned in the same way as a retaining wall, a common value for the thickness at the base is 3-7ths of the height. They are supposed to be built plumb behind. For a unit of length of the culvert the cubic contents of masonry are then (neglecting the pavement),

$$\tfrac{3}{7}h \times h \times 2 + S \times t = \tfrac{6}{7}h^2 + St. \qquad (1.)$$

The thickness of the covering-stone, considering it as a beam supported at the ends and uniformly loaded, neglecting its own weight, should be by the ordinary formula (see Trautwine's Pocket-book):

$$\frac{(12t)^2 \times 45}{2S} = 10bS.$$

$$\text{or, } t = \frac{\sqrt{b}}{18} S$$

Substituting in (1) we have,

$$\text{cubic contents} = \tfrac{6}{7}h^2 + \frac{\sqrt{b}}{18}S^2 = \tfrac{6}{7}h^2 + \frac{\sqrt{b}}{18}\frac{a^2}{h^2}$$

To find when this is minimum, place the first differential co-efficient equal to zero, or

$$1\tfrac{2}{7}h - \frac{\sqrt{b}}{18}a^2\frac{2h}{h^4} = 0$$

$$\text{or, } \frac{\sqrt{b}}{9}\frac{a^2}{h^4} = 1\tfrac{2}{7}$$

$$\text{or, } \frac{S}{h} = 6\sqrt{\frac{3}{7\sqrt{b}}}$$

If b equals 15, this equation reduces to 2, which "Subscriber" says is the usual value.

The assumption, however, that the thickness of the walls is based in the same proportion as a retaining wall, does not hold good in practice for small culverts. It would give too thin a wall for ordinary heights. They are never made less than two feet. If we start with this as the thickness, equation (1) becomes,

$$4h + \frac{\sqrt{h}}{18}S^2$$

which is a minimum when

$$\frac{S}{h} = 6\sqrt[3]{\frac{6}{ab}}$$

If a equals 6, this value becomes 2 (or the usual value according to "Subscriber") when b equals 27.

It appears to the writer that the question is more curious than useful, since the ordinary size of the stream to be crossed would generally fix the width, and the size during floods would fix the height. C.

ADRIAN, MICH., *July 16, 1877.*

Editor ENGINEERING NEWS:

SIR.—If "Apostle," in your issue of the 14th inst had an opportunity of consulting the Session Laws of Michigan for 1873, he would have found his suggestions anticipated. The section, in reference to town plats, is very explicit and a timely means of preventing litigation in the future from incorrect and insufficient records.

This law requires the plat to be drawn upon a sheet of good muslin backed paper eighteen by twenty-four inches in size; with a full and detailed description of the land embraced in the plat, and its connection with the Government surveys by section lines and corners.

There shall also be on the plat a plain designation of the cardinal points and a correct scale.

The plat shall be signed by such proprietors and engineers, or surveyor making the same, and shall be witnessed and acknowledged as deeds conveying land are witnessed and acknowledged. Two duplicates of the plat, in every respect, are required which are certified to by the register of deeds for the county and the engineers. One copy being placed on file in the register's office by being securely fastened in a book of proper size so that the plat shall not be folded.

The other duplicate shall be delivered to the Auditor General of the State who shall file the same in his office.

Respectfully, G. E. KEDZIE, C. E.

A LOG SURVEY.

PORTLAND, ME., *July 12th, 1877.*

Editor ENGINEERING NEWS:

SIR.—I have recently made a survey of several lakes, and I think perhaps the manner of accomplishing it possesses novel features sufficient to interest some of your readers.

I cannot do better than state the necessity that demanded the experiment upon which I realised so happily.

An injunction was prayed for to restrain a dam owner from venting the water through a sluice-way during the night; it being affirmed that more than the natural flow of the feeders above was vented, in fact that it lowered the reservoirs at the alarming rate of six inches in ten hours.

When I had looked at the chain of lakes forming the reservoirs I felt that the affidavit must be a serious blunder or a willful misrepresentation to make positive proof of the error and demonstrate it. I had three days before the case was to come into court. Of course it was necessary for me to know the surface area of the reservoirs, and it is of the manner in which I accomplished this that I propose to relate. The lakes forming the reservoirs were in an unsurveyed and densely wooded country. Having been raised above their natural surface, no beach existed.

To traverse their perimeters was therefore a labor requiring quite a party and several axemen and two or three weeks time. To triangulate them also required nearly the same time owing to the bad features of the shores. What I did was this: I procured a light boat with two good oarsman and an *Improved Log* that records by its screw revolutions the distance passed over, the recording dial being similar to a gas metre dial. I was not prepared to trust my Log, rated as it was to salt water without first rating it to fresh water and the jerky progress of a row boat combined. Therefore I selected a thin wooded vicinity and measured a base line and cut rangeways perpendicular to it out of the shores of the lake. In the rangeways I placed range flags that could be seen from the lake. On this base I rated my Log. I sat in the stern of the boat and with a short rod hung the Log in the water about three feet off or just far enough to escape the eddy of the boat, and near enough to escape that made by the oars. I rowed over my base three times, twice with no difference on the dial, and the third time the difference was not significant.

My base was 973 feet in length and represented on the dial 5-32 of the Log mile, which determined *my* nautical mile to be 6227 as against 6200 feet, the Log mile as rated by the maker. With my stop watch I also determined the number of seconds occupied in rowing the base, and when I had rowed the entire length of the lake my equated Log distance was 8007 feet and my time distance was 8200 feet. Having thus determined the length, the first lake being quite uniform, I simply measured a sufficient number of equidistant ordinates and allowed them to accumulate upon the dial and took their mean. The other two lakes I measured in a similar manner, except that I measured the position of cross measurements where it was evident that equidistant ordinates failed to give the correct area. Proceeding in this manner, in one day and a half I measured and determined the area for over 20,000,000 sq. ft. of lake surface near enough for practical computing purposes, when to have arrived at the same result by any other method, would have taken between two and three weeks, and quite a party of men. As regards the application of the result, although possibly interesting, I have but to say that it verified my supposition.

In rowing I endeavored to have my men maintain the same speed that they did upon the base test, and I think that with most logs it would be necessary to approach 4 miles per hour. My own time was 4 1-7 miles per hour.

I was not prepared to expect the degree of accuracy that I obtained; in fact, a result considerably less accurate would have answered my case. But I am prepared now to believe that much valuable information can be obtained by the use of the Log that otherwise the expense would make impracticable. E. C. JORDAN.

The following are the elections, changes, and corrections for the month of June, 1877, in the membership of the American Society of Civil Engineers:

Additions:—Hardee, Thomas S. Chief Engineer, Louisiana Levee Co., New Orleans, La.; Harrod, Benjamin M. Architect and Assistant City Engineer, New Orleans, La.; Hillman, Charles F. Civil Engineer, Chili, S. A.; Keefer, Thomas C. Ottawa, Canada; Le Conte, Louis J. Resident Engineer in Charge of Harbor Improvements, Oakland, Cal.

Changes and Corrections:—Baxter, George S. 227 Lexington avenue, New York; Bissell, H. East Windsor, Conn.; Bogue, Virgil G. Care Henry Meiggs, Lima, Peru; Briggs, Robert 220 S. Fourth street, Philadelphia, Pa.; Broadhead, Calvin E. Hickory Run, Carbon Co., Pa.; Brown, Robert N. Care Maj. Whitney, Niagara Falls, N. Y.; Buck, Leffert L. Care Col. W. H. Paine, Pier 29, E. R. New York; Francis, Henry N. Assistant City Engineer, 34 N. Main street, Providence, R. I.; Gunn, Otis B. Lawrence, Kansas; Horton, Sandford, Assistant Engineer, Albert Lea Extension, B. C. R. & N. R'y. Northwood, Worth Co., Iowa; Knight, William B. 240 E. Seventy-seventh street, New York; Rice, Edward C. 3631 Baker avenue, St. Louis, Mo.; Roberts, W. Milnor Middleton, Annapolis Co., Nova Scotia; Stauffer, David M. 127 S. Thirteenth street, Philadelphia, Pa.; Stuckle, Henry W, Care W, E. Worthen, 63 Bleeker street, New York; Swan, Charles H. 35 N. Main street, Providence, R. I.; Weir, Frederick C. 507 W. Seventh street, Cincinnati, O.

Deceased:—Nickerson, Louis, Baltimore, Md., May 6th, 1877.

THE DYNOGRAPH.

The dynograph car of the Eastern Railway Association, in charge of P. H. Dudley, has been running between Springfield and Worcester, on both freight and passenger trains, to test the relative amount of power required at different points along the road, especial reference being had to the Springfield and Charlton grades. The experiment on the Modoc train east, leaving Springfield at 6.30 A. M., which consisted of two sleepers, four passenger, and baggage cars, and the dynograph car, showed power required as follows: For the first 2,920 feet out of the depot the tension on the draw-bar was 6,526 pounds; for the next mile 6,460 pounds, the rate of speed being 32 miles per hour; for the next 6,200 pounds, the speed being 36 miles, and for the last 1,100 feet the top of the grade, 6,250 pounds. The last mile required the engine to produce 19,625,800 foot-pounds of power per minute, the term foot-pound indicating the power required to lift one pound one foot. In going up the grade from East Brookfield to Charlton, beginning at the station, the tension on the draw-bar for the first 3,880 feet was 5,722 pounds; for the first full mile, the velocity being 37 5-10ths miles, 4,280 pounds; for the second mile, with 37 miles velocity, 5,232 pounds; third, with 36 miles velocity, 5,450 pounds; fourth, which contains a sharp curve, with 37 miles velocity, 5,612 pounds; fifth with 41 miles velocity, 5,230 pounds; and, sixth, which ran a little past the summit at Charlton, 4,356 pounds. The engine had an 18x24 cylinder, and the track was in excellent condition. The maximum of the Springfield grade is 60 feet to the mile, and the Charlton grade 51 47-100ths feet. At the sharpest curve the grade is about 49 feet. Similar experiments were made on a freight train of 27 cars drawn by the Adirondack, famous for her trials with the Mogul engine last summer, and showed that the tension on the draw-bar going up Springfield grade, at a speed of 5 9-10ths miles per hour, was about 16,000 pounds, and the average strain going up Charlton grade, at an average speed of but 9 miles per hour, was 14,500 pounds, the power required in the first instance being 84,840,000 foot-pounds. Near the top of the grade the power of the engine was tested by applying the brakes, and it was found that, running at four miles per hour, the engine could exert a tension of 17,000 pounds. Beyond this point the drivers would slip and made but little progress.—*Exchange.*

CONTRACTORS' INTELLIGENCE.

The contract for the new College street bridge at Rochester, Minn., has been awarded to Horace E. Horton at $5,800.

M. K. Chase of Blue Hill, Me., has been awarded the contract for furnishing cut granite for the pedestal for the statue of the late Major-General George H. Thomas, to be erected in Washington.

The Supervisors of Lake county, Ills., closed their session at Waukegan on the 13th inst. It was voted to build a Court House at Waukegan, at a cost not to exceed $40,000. The plans are nearly ready. Bids will be advertised for at once.

The City Council of La Crosse, Wis., on Saturday evening the 14th inst., adopted a resolution, authorizing the construction of a system of waterworks in the city, with necessary pipes, hydrants, etc., at a cost not to exceed $15,000, the work to be prosecuted with as little delay as possible.

West Bay City, Mich., has received and is about to lay a short line (1300') of water pipe, 6 inches in the principal business section of the city, for fire protection. The water will be brought from Saginaw River through Knowle's Steam Pump at H. W. Sage's Mill. As soon as the necessary hydrants are received, proposals for laying the pipe will be called for.

At a meeting of the Trustees of the Institution for the Blind, in Columbus, Ohio, on the 10th inst., T. R. Tinsley, architect, submitted plans and specifications for workshops and a stable at the institution, the estimated cost being $9300. The plans were examined by the Board, approved and ordered that advertisements be inserted for bids to construct the same according to law. The appropriation made by the Legislature for this work was $10,000.

The Lake Shore & Michigan Southern Railway Company closed a contract on the 14th inst. with the Keystone Bridge Co. of Philadelphia, through their engineer, Mr. A. Gottlieb of Chicago, for a new bridge over Ashtabula Creek, at Ashtabula, Ohio. The plans adopted were made by the Keystone Bridge Co. based upon specifications of L. H. Clarke, Esq., Chief Engineer of the road. The structure will be exceptionally strong in every detail.

The Delaware Bridge Company have contracted with the Pennsylvania Railroad Company for a bridge at Rockville station, to cross the Susquehanna river just above Harrisburg. A. & P. Roberts & Co., Pencoyd Iron Works, make nearly or quite all of the iron. The Edge Moor Iron Company do the fitting and prepare the iron for erection. The aggregate weight of iron will be about 7,000,000 pounds. The bridge will be completed before December next.

At New Haven, Conn., July 5th, proposals were opened for furnishing materials and constructing sewers in Whitnep avenue and Highland street. The work included about 600 feet 30-in. brick sewer, 1000 feet 24-in. brick sewer, 400 feet 15-in. pipe sewer, 400 feet 12-in. pipe culvert, 11 basins, and 14 manholes; and on the estimate of quantities, the prices were as follows: Lawrence O'Brien, New Haven, $5,816; William Grandfiele, New Haven, $6,268; Devlin & McKien, New York, $9,510; Wm. S. Fowler, New Haven, $9,780; Michael Fritzpatrick, Hoboken, $9,860; Matthew Kehoe, New, Haven, $10,797. The contract was awarded to Lawrence O'Brien. The engineers estimated on the work was $7,500; the average cutting being about ten feet, with considerable water to be encountered.

The Boards of Trustees of Lake and Hyde Park Ills., held a joint meeting at the latter town Thursday evening, the 12th inst. It was, after much discussion, resolved, that the villages of Lake and Hyde Park immediately enter into contract with the Holly Manufacturing Company for the repair of the present machinery of the water works in accordance with the company's proposition, and that a bond of $5,000 be required for the completion of the work, and that they advertise for bids for machinery of not less than 3,000,000 gallons capacity per day.

NOTES.

Seamless steel wheelbarrows are now being made at Harrisburg, Pa.

General Burt, with a party of engineers, is on the ground locating the line of road to be built from the Massachusetts line to Schenectady.

The engineer of the Brooklyn bridge gives the following notice to mariners; On and after July 11 the strands of the East-river bridge cables will be in their final position, which will be at the lowest point at the middle of the river, 145 feet above high water.

WHITE HOUSE WHITEWASH.

The following recipe, which is frequently inquired after, is given for the famous whitewash with which the Presidential mansion is adorned:

Take one-half bushel of nice unslacked lime, slack it with boiling water; cover it during the process to keep in the steam. Strain the liquid through a fine sieve or strainer and add to it a peck of salt, previously dissolved in warm water; three pounds of ground rice boiled to a thin paste; one-half pound of Spanish whiting, and one pound of clean glue which has been previously dissolved by soaking it well, and then hang it over a slow fire in a small kettle within a larger one filled with water. Add five gallons of hot water to the mixture, stir it well, and let it stand a few days covered from dust. It should be put on hot, and for this purpose it can be kept in a kettle on a portable furnace. About a pint of this mixture would cover a yard upon the inside of a house, if properly applied. Fine or coarse brushes may be used according to the neatness of the job required. It answers as well as oil paint for wood, brick or stone, and is cheaper. It retains its brilliancy for many years. There is nothing of the kind that will compare with it, either with inside or outside work. Coloring matter may be added at any shade desirable except green, for which there is no material that can be used with lime. Spanish brown will make reddish pink when stirred in, more or less deep according to quantity. A delicate tinge of this is very pretty for inside walls. Finely pulverized common clay, well mixed with spanish brown, makes a reddish stone color; yellow ochre stirred in makes a yellowish wash, but chrome goes further, and makes a color generally esteemed prettier. It is best to try experiments on a shingle and let it dry.

RAILROAD NOTES.

The St. Louis, Iron Mountain & Southern R. R. has established an office in chicago, which is at present in charge of Mr. C. W. Adams, of the Erie and Chicago line.

The great railway bridge over the Maas, at Rotterdam, by which direct railway communication between Antwerp and Rotterdam has been established, was formally opened on the 28th of last month. It cost nearly a million of dollars.

The Lake Erie & Louisville R. R. Co., are making surveys preparatory to extending their line by a branch 61½ miles long, from St. Mary's, O., to Muncie Ind., and by another branch about 36½ miles long from St. Mary's to Union City, Ohio. Efforts are also being made to raise the money for extending the line from Fremont, its present Northern terminus to Sandusky.

The Colorado Central R. R., will be completed to Longmont from Hazard on the Union Pacific R. R., and operated to Cheyenne this year. The Black Hills survey will be continued probably until cold weather; the party are now just north of the Niobrara River, in charge of Jos. A. Crawford. The Colorado Central party in charge of P. F. Barr, both under the direction of Jas. A. Evans.

At a large and enthusiastic meeting, held at Osceola, Clarke county, Ia., last week, articles of incorporation of the St. Joe, Osceola & DesMoines Narrow-gauge R. R. were adopted, and officers elected. It is understood that the proposed new route, which will run through a rich and improving country, will be operated by the DesMoines & Minnesota R. R. The projectors hope to obtain State aid.

B. H. Bryant, C. E., of this city, has been engaged to make an examination of a number of the bridges on the line of the Baltimore and Ohio R. R., concerning which litigation is pending.

A survey of the Harrisburg and Potomac route has been made from Shippensburg to Chambersburg, Pa., and it is said that property holders along the line will donate the entire right of way. The road, if built, will run parallel to the Cumberland Valley road.

Peru's example is catching all over South America, and the continent seems to be on the verge of a general revival of railway building. All the old plans are aganin up for discussion. One of the most interesting is that for a road from Buenos to the Pacific at Santa Rosa, Chili, which will tunnel the Andes at the height of 10,500 feet, the perforation being two miles long. It is now nnder debate in Congress of Buenos Ayres.

They are now engaged at the Patten car works at Bath upon a contract from the European and North American Railway Company to change the rolling stock from broad to standard gauge. The change in the gauge of the E. and N. A,, which will probably not be long delayed now, will bring up the question, whether it will be advisable to change the guage of the Bangor and Piscataquis road, Maine, or leave it as it now is and transfer the passengers and freight to Oldtown.

Judge Blodgett, of the U. S. Supreme Court was occupied a portion of July 10th in hearing the case of Joseph E. Roy against the Pennsylvania Company. Roy had a sleeping-car berth on the defendant's line, form this city east, and, when about fifty miles on his route, the berth fell, injuring him severely. The defendants claimed they were not liable. but the jury held they were, and found in favor of the plaintiff for $10,000.

PUBLICATIONS RECEIVED.

Annual Reports of the City of Somerville. Mass., for 1876,

Catalogue of Cornell College. Mount Vernon, Iowa, 1876–1877.

Centre of Gravity of Earthwork: J. Woodbridge Davis, C. E.

Catalogue of the State University of Iowa. Des Moines, Iowa, 1876–1877.

The Western Review of Science and Industry, for June 1877. Kansas City, Mo.

Fifth Annual Report of the Board of Police Commissioners. Cleveland, Ohio, 1877.

Commissioners' Report of the United States Commission on Fish and Fisheries. Washington, 1876.

The Pneumatic-Electric System for lighting and extinguishing the gas used for street lights, etc. John H. Blake. Boston, 1877.

On the Production and Use of Compressed Air in Mining Operations. By M. F. L. Cornet. Translated from the French by Robt. Zahner, Stevens' Institute of Technology. Re-printed from "Journal of Franklin Institute." Philadelphia, 1877.

The *Atlantic Monthly* for August contains: German Influence in English Literature.—Thomas Sergeant Perry; Mutation,—Celia Thaxter; A Counterfeit Presentment. Comedy. —W. D. Howels; Crude and Curious Inventions at the Centennial Exhibition.—Edward H. Knight; Forward.— J. W. De Forest; The Queen of Sheba.—Thomas Bailey Aldrich; A Ghost.—Mrs. S. M. B. Piatt; King Cotton and his Gin. Dropping Corn.—Maurice Thompson; A Great Italian Noble's Palace and Household.—Angelo Tacchella; The Wanderers — C. P. Cranch; How Captain Ascott Floored the Ghost.—Will Wallace Harney; Cousin Patty.—Marian Douglas; The Shadow of Dickens's Life.—Edwin P. Whipple; The Contributors' Club, Recent Literature. Education.

Harpers' Monthly for August contains: The White Mountains,—William H. Rideing; The Golden Treasures of Kurium.—William C. Prime; A New Watering Place.—Elizabeth E. Evans; The Poet Keats.—Edward F. Madden; The Jet Black Groom.— Thomas Davidson; Home Observations in Florida.— Mary Treat; Erema; or, My Father's Sin.—R. D. Blackmore; Reality. A Poem.—Helen S. Conant; Voudoo Violet. A Story.—Lizzie W. Champney; Good Morrow. A Poem.—A. F.; Pan-Fish Angling.—Maurice Thompson; Friend Brook. A Poem.—Lucy Larcom; Mahomet. — Eugene Lawrence; Hints for practical Trout Fishing.—Douglas Frazar; Inside Plum Island. A Poem —Harriet Prescott Spofford; Popular Exposition of some scientific experiment. Part V.—Dr. J.W. Draper; The Flying Proa —William D. Alden; The Fairies' Table-Cloth. A Poem.—Margaret J. Preston; The Old South Meeting-House. A Poem.—Edward Everett Hale; Bell's Match-Making. A Story.—Mary N. Prescott; Sunrise on Mount Washington. A Poem.—Anna C. Brackett; The Waving of the Corn. A Poem.—Sidney Lanier; Percy and the Prophet.—Wilkie Collins; Editor's Easy Chair. Editor's Literary Record. Editor's Scientific Record. Editor's Historical Record. Editor's Drawer.

ARCHES;

CONSIDERED GRAPHICALLY.

(*Continued from page 170.*)

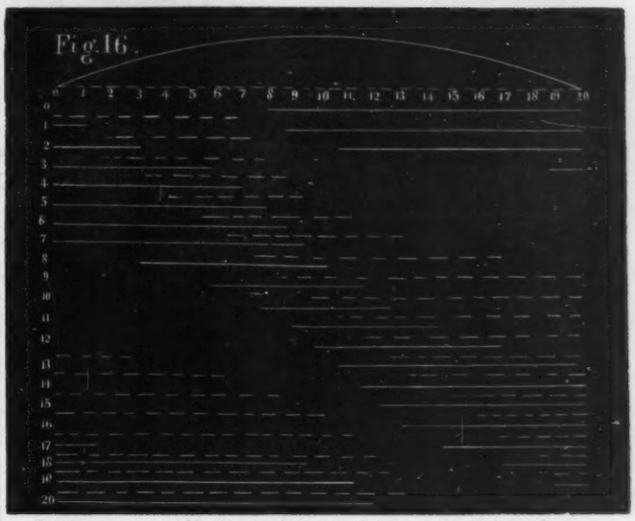
or bracing for all the divisions of the first and last quarters of the span, and less for the middle half of the span, than an arch with hinged ends. These considerations alone would indicate the superiority of the arch with fixed ends over the other type, as requiring less material in the flanges or chords, and throwing the heavier bracing towards the abutments; the value of the direct thrust, however, as indicated by the previously computed amounts of H, varies according to the amount of load, and conspires with the compression from bending moment, so that the sections of the two chords have to be designed for the maximum compression and tension at all points; the effect of rise or fall of temperature is greater on the rib with fixed ends, requiring a greater increase of section to provide for it.

77. If the arch, when either fixed or hinged at the ends, is exposed to a change of temperature, it will tend to change its shape. If the rib were perfectly free, its expansion or contraction would be uniform in all directions, so that the new arch would be the old arch on a slightly altered scale. In a bowstring girder, the tie expands and contracts with the bow, so that the horizontal projection of the change of the length of the bow is the same as the elongation or contraction of the horizontal member. The alteration of the arch by a change of temperature is manifested by a rise or fall of the crown of the arch, and this movement, in the case of a metal rib, is often a very noticeable quantity. As the abutments are considered to be fixed, the span remains unchanged.

It is manifest that, if we imagine the rib at its normal temperature to be placed upon its springing points or skewbacks, it will have a horizontal thrust against the abutments due to its form and weight. If the temperature changes, the structure endeavors to expand or contract in equal proportion in all directions, and hence, if possible, the span would be lengthened just in proportion to the rise of temperature t, the coefficient of expansion e, and the span $2c$, or the change of span would equal $2tec$. If t, expresses the number of degrees of fall in temperature, it may be called *minus*, and the quantity $2tec$, will denote the shortening of the span. But this attempted change of length, being resisted at the points of attachment, cannot take place, but must cause a horizontal force, either tension or compression, which keeps the span invariable. This + H or − H must exert a bending moment upon all parts of the rib, which moment is too important to be neglected. It being recollected that the condition $\Sigma E F . D E = 0$ denoted that the change of span equals zero, it will be sufficient in this case to still make it zero, when we have added or subtracted a quantity proportional to $2tec$.

78. As some readers may not be familiar with investigations upon the flexure of beams, we will devote a little space to recalling some essential principles. Let one imagine two bars, the one of iron and the other of wood, of the same length and the same cross-section, to be firmly held by one end horizontally, and to have equal weights attached at the free ends. We all know that the deflections of the two bars below the original horizontal line for similar points will not be the same, nor will the changes of inclination. The amount of deflection will depend upon the material of which the bar is made, and, from experiments upon deflection, a quantity known technically as the *modulus of elasticity* is deduced, varying with the material. The bar which elongates and compresses most for a given stress on the square inch will bend the most as a beam under a given load, and therefore the ratio of the force on the square inch to the elongation and compression of a unit in length which it produces, and which is the modulus of elasticity above referred to, governs the flexure of any member under a bending moment. As the change of length is the denominator of this ratio, the more rigid body, the one which bends less for a given bending moment, other things being equal, will have a higher modulus of elasticity; therefore the curvature, change of inclination and deflection will vary *inversely* as this modulus. Let it be denoted by the symbol **E**. Its values will be found in tables of strength of materials.

79. Again:—If we compare the action of two beams of the same length and material, of different but similar cross-sections, we know that they may not deflect equal amounts for the same weight, similarly placed. If they are of equal depths, the broader one will be the stiffer, and, if the breadths are the same, the deeper beam will be much the stiffer. By mathematical investigation which it is not expedient to reproduce here, it may be shown that the stiffness of beams of similar cross-sections varies directly as the breadth and as the third power of the depth; the quantity which contains the variables for any form of cross-section is known as the *moment of inertia*, and may be represented by the symbol **I**. The stiffness being directly proportional to **I**. the change of inclination and the deflection will vary inversely as **I**.



Full line = extent of load to produce max. + M on points designated.
Broken line = equals extent of load to produce max. + F between points designated.
Blank space for max. − M. do. for max. − F.

PARABOLIC ARCH FIXED AT ENDS. TABLE FOR F. $F = tW$. VALUES OF t.

Point of Division.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
W on 1	.961	.036	.033	.029	.026	.022	.019	.016	.012	.009	.006	.002	.001	.005	.008	.011	.015	.018	.022	.025
" a	.857	.869	.119	.107	.095	.083	.071	.058	.046	.034	.022	.010	.002	.015	.027	.039	.051	.063	.075	.087
" 3	.708	.732	.756	.819	.195	.170	.146	.122	.097	.073	.049	.021	0	.025	.049	.073	.098	.122	.147	.171
" 4	.531	.570	.608	.646	.315	.277	.238	.200	.162	.123	.085	.046	.008	.030	.069	.107	.140	.184	.222	.261
" 5	.343	.396	.448	.501	.554	.394	.341	.288	.235	.183	.130	.077	.025	.028	.081	.134	.186	.239	.292	.345
" 6	.156	.222	.288	.354	.420	.486	.448	.331	.315	.249	.183	.117	.051	.016	.082	.148	.214	.280	.346	.413
" 7	.019	.058	.136	.214	.291	.309	.447	.476	.398	.321	.243	.165	.088	.010	.068	.145	.223	.301	.378	.456
" 8	.173	.056	0	.086	.173	.259	.346	.432	.452	.395	.309	.222	.130	.050	.037	.123	.210	.296	.382	.469
" 9	.298	.206	.115	.023	.069	.161	.253	.345	.437	.471	.379	.287	.195	.105	.016	.082	.172	.264	.356	.448
" 10	.390	.397	.303	.109	.016	.078	.172	.266	.359	.453	.471	.379	.287	.195	.104	.037	.109	.203	.297	.390
" 11	.448	.356	.264	.172	.031	.012	.103	.195	.287	.379	.471	.437	.345	.253	.161	.069	.023	.115	.206	.298
" 12	.469	.382	.296	.210	.123	.037	.050	.130	.222	.300	.395	.482	.432	.340	.258	.173	.086	0	.115	.173
" 13	.456	.378	.301	.223	.145	.068	.010	.038	.105	.243	.321	.398	.476	.447	.369	.291	.214	.136	.058	.019
" 14	.413	.346	.280	.214	.148	.082	.016	.051	.117	.153	.249	.315	.381	.448	.436	.420	.354	.288	.222	.156
" 15	.345	.292	.239	.186	.134	.081	.028	.025	.077	.130	.183	.235	.288	.341	.394	.554	.501	.448	.396	.343
" 16	.261	.222	.184	.146	.107	.069	.030	.008	.046	.085	.123	.162	.200	.238	.277	.315	.646	.608	.570	.531
" 17	.171	.147	.122	.098	.073	.049	.025	0	.024	.049	.073	.097	.122	.146	.170	.195	.219	.756	.732	.708
" 18	.087	.075	.063	.051	.039	.027	.015	.002	.010	.022	.034	.046	.058	.071	.083	.095	.107	.119	.869	.857
" 19	.025	.022	.018	.015	.011	.008	.005	.001	.002	.006	.009	.012	.016	.019	.022	.026	.029	.033	.036	.961

(*To be continued.*)

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 186.*)

The brake is shown at *f*, *f*, and consists of four wooden brake-blocks, attached by iron shoes to a bar behind them and having rubber packing between the shoes. The screws shown and the handles *h*, are used to operate these brakes. The cranks *m*, working the screws *n*, operate the scrapers *l*, which are used to keep the roller clean in muddy weather. The frame A, is made heavier at *o*, so as to have increased weight there to balance the whole frame-work in turning around. The support *p*, and the guide wheel *k*, might be dispensed with. A great saving in time and in movements hurtful to the road is effected by making the frame circular as described, this allowing the roller to be turned with the greatest ease. The dimensions are figured on the drawing. A roller of this kind four and one-half feet in diameter, and three and one-half feet long, and weighing some four tons when empty, would cost perhaps $560 to $600; one5 ft. by 3 ft. 8 in., weighing about five and one-quarter tons (empty,) some $700 to $750. Leaving off the break, would diminish the cost about $50.

Before leaving the subject of macadam top roads, it ought to be mentioned that a bed of rubble stone 10 or 12 in. deep, merely spread uniformly over the road-bed as a foundation, is better than nothing at all, but can never make the same quality of road as the rough paving described above.

The following data are to be used in estimating the cost of the kind of road just described. Rough foundation paving, pieces 5 to 6 in. long, filling up crevices and ramming the whole with hand rammers, costs, after the material has been brought to the spot, one day's work of a common laborer for every four square yards, this assuming that the paver gets one and two-thirds common laborer's wages. Same kind of paving if set in sand will cost one day's work of a common laborer for every two and one-quarter square yards.

These figures for the cost of setting rough pavement for a foundation course have been objected to by an American road contractor, as entirely too high, he claiming to set 20, and even 50 square yards to a man per day. An explanation of these different figures probably lies in the phrase, "ramming the whole with hand rammers"; in the general quality of the work done, etc., the writer's own opinion is, that no very fine work is necessary in the construction of the foundation course. Its duties are, to remain pervious, and not to settle unevenly. The same contractor above mentioned wrote, in 1870: "I put down, and keep in perfect order for a year from the time of completion, a 12-inch road (6 to 7 inch foundation, 5 to 6 inch surfacing) at a distance from the quarry of three miles (materials exclusively quarried trap rock), for $1.50 per square yard; wages of men average $2.25 per day, and of transportation, $1.25 per cubic yard. This includes my profit."

To make macadam by hand costs, for sizes from 1¼ to 1½ in. of very hard rock, one day's work for every 0.6 to 0.44 cubic yards, for less hard rock, one day's wages will make 0.7 to 0.6 cubic yards, and of soft rocks 1.76 to 1.17 cubic yards.

In 1872 the estimated cost of crushing stone by the Blake machine ranged from 30 to 60 cents per cubic yard; to crush the same stone by hand, it was estimated would cost from $1.20 to $3.00 per cubic yard.

To spread 14–12 cubic yards of macadam is also about a day's work.

Gravel Top.— Instead of the macadam top described in the preceding articles, screened gravel may be used. These roads are the favorite ones in Central Park, New York, and are probably the best road there is for pleasure drives. It is a matter of some doubt yet whether they do as well for heavy trucking as they do for light vehicles. The foundation for these gravel roads should be the same as the rough paving for the macadam road; some pieces were built in Central Park having a rubble stone foundation, but they are not recommended by their builders. The gravel to be used for the top must be selected with some care; it should be of a hard kind of stone, clean, that is, free from clay, etc., of the right color, etc. It is put on in two layers, each rolled, and the top one made compact and firm, by spreading and mixing in some good binding material, sprinkling and rolling. There need be no fear of making a poor road by using the smoothest, most water-worn pebbles, free from all sand, etc., in making a road-top. The upper portions of the river Rhine are remarkable for the clean, smooth pebbles that form its bed to a very great depth. These pebbles are dredged up and used in road-building, making an excellent road-covering at a small expense.

In gravelly soil all the materials that are needed for a good road are frequently on the spot; they only need sorting out and re-laying. For this reason a common gravel sieve often constitutes the principal instrument, whose judicious use will make a good road out of a miserable string of ruts and cobbly elevations. It would be only necessary to sift out and separate the soil under the road to a sufficient depth, into cobbles, coarse gravel, fine gravel and sand; then replace them in the order named and with the proper thickness of layers of each; wet down and roll, and the result would be a good road. As regards the advisability of well constructing roads, the following, from the Bath (Maine) *Times*, of May 11, 1870, is not without instruction (the Waltham roads therein spoken of are also mentioned in the extracts from a report, which is printed in the Appendix: "I will here submit a comparison of the cost of our road, with those of the town of Waltham, noted for its *good* roads. Waltham has 51 miles of roads; the expense, including everything, of maintaining their highways, except sidewalks, for seven years previous to 1868, was $3,357 per year, or $66 per mile. In 1868, with 60 miles of road, including probably the building of 9 miles, the cost was $6,000, or $100 per mile. The city of Bath has not over 32 miles of roads. The average cost of repairs on our roads for the three past years is $10,153; not including the expense of sidewalk, $317 per mile. At this rate, if we reduce the cost of repairs of our roads to $100 per mile, we could afford to hire money at 7 per cent. and expend $100,000 upon their *permanent* improvement, and it would be vastly cheaper to do so than to continue our present system."

There are many miles of such roads in Baden and in the Bavarian Rhine Provinces.

Keeping Roads in Repair.— This subject properly finds its place here, being a matter of skill and a thing of debate only in the case of what we have called foundation roads; pavements and trackway roads, to be considered after this, need no special directions as regards their repair or maintenance.

After a road has been properly rolled, and the surface made compact and smooth, it should always be maintained in that condition, no matter how great is the amount of travel on it. "A stitch in time saves nine," here as well as elsewhere. The tendency is to produce ruts; these gather water; this soaks up the road-bed and spoils the whole. The problem can be put in this way: To have a good road it is necessary that there be no dust or mud on the same, and that there be no ruts; therefore, remove the dust and mud as fast as they are formed, and fill up the ruts as fast as they are made. The whole matter is here in a nut-shell. It may be thought, at the first view, that this is too expensive a system. Its principal beauty lies, however, in the fact that it costs less per mile of road kept one year than the pernicious system of annual or semi-annual repairs, as will be shown and proved. The above two rules — sweep off the mud and dust as fast as they are formed, and fill up the ruts and bad places with new material as fast as they appear — are all that is necessary to be carried out in order that there be *continually* a good road. Without continual repairs, there can be no such thing as a constantly good road — a proposition that cannot too often be repeated. By repairing a road annually, or twice a year, it matters not which, the result is, strictly speaking, a *good* road at NO time during the whole year. The road is wretched just after repairs; it becomes *passable* after a while, and deteriorates from that day forward, until it is again made wretched; and so on, *ad finitum*, according to the present only too commonly followed system. By the other method is offered us a road as smooth as a floor, year in, year out, and, let it not be forgotten, *at a less expense.*

(*To be continued.*)

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

RAILWAY ECONOMY.

It cannot be disguised that there is a wide sympathy for the striking railroad employees. A ten per cent. reduction on a salary of $5000 or $2500, is hardly felt and may be repeated several times before actual poverty ensues, but the same process applied to $3,00 and$ 1,50 per day very soon brings a man who has a family depending on his earnings, to a bare existence. But if the men do not like their pay, they can leave and let other men who will accept it take their places; the railroads have been losing money; the water is being squeezed out of their stock; the sleeping car companies must make dividends; fast freight line must pay; wars for traffic must be kept up, high salaries must be paid to leading officials, and dividends *must* be paid to stockholders; there must be economy somewhere and to the average railway director or president, who is enjoying himself at Saratoga or Long Branch, there is no way so simple, so easy of execution, as ordering by telegraph, a reduction of wages. It does not require any brains to do that, and to a man who is accustomed to that sort of a thing, not even courage is necessary. The common plea of "leave if the pay does not suit," is not altogether a just one and the traveling public right here have some rights in the matter, to be observed. A high priced freight agent will look quite patronizingly on a switchman, but the latter, as he watches through the long nights mayhap in a blinding storm, or with the mercury below zero, holds the lives of hundreds in his keeping, while the main duties of the former now-a-days seems to be to sit in council with his fellow agents and make treaties to be violated from the outset, and to devise schemes of plunder or waste of stockholders' property which the wages of all the switchmen and brakemen in America would'nt balance. A master mechanic over-ranks an engine-driver, but while the latter, with his hand on the starting-bar is watching track, and switch, and signal, and with his life in his hand day and night, is really occupying the most responsible position on a railway, the former is devising ways and means by which more money is wasted to the stockholders than the combined wages of all the engine-drivers in America will balance. Trained in one or two shops, with no education but that acquired from his surroundings, self-conceited and self-reliant, the average master mechanic of the present railway service of America has cost and is costing railway stockholders millions of dollars that might be saved, and after paying fair wages to the men that really earn their money would leave something respectable for dividends. The rolling stock of no two roads in the country are alike, a little device in iron or wood here, and another there, is introduced, and thousands of cars must be changed, and all the roads of the country must add to their stock of material for repairs, until yards are cumbered with it and a constantly growing and burdensome tax is imposed. An inventory of the stock for repairs of its own and foreign cars by one of the trunk roads last year showed one million of dollars lying idle, when a common system of construction and interchangeability of parts would necessitate only a few thousands besides a great saving of time. Experiments have shown that only six per cent. of the effective power of the fuel used in locomotives is utilized, the rest being wasted, and yet scarcely a master mechanic or a railway superintendent in the United States, can be induced to make an effort to stop this item of waste. Experiments with the dynagraph have developed the greatest ignorance on the part of car builders, but under the existing system of management little improvement may be anticipated.

We consider then, that the higher officers of our railroads are as a rule utterly incompetent to fill their positions and are largely responsible for the present troubles through their mismanagement and ignorance; and the stockholders who own more than $2,000,000,000 of valuable railway property lying in every portion of the continent, are to blame in allowing this property to be managed in the reckless, selfish, wasteful and incompetent manner in which it is without ever raising a finger to prevent it. There are men in this country who are competent to manage these trusts, who would honestly do it, and who by education are especially fitted to take intelligent cognizance of all the details of the complicated management of a railway, but they are not usually to be found in the lawyers, merchants, bankers, and occasionally promoted conductors, or station agents, who by virtue of money or influence now fill the office of Superintendent or Receiver of our railroads. If the people who own the railroads will look after their property they may very materially help along the time when dividends may be obtained regularly, and without the introduction of pauper labor, and the possible consequences of its criminal carelessness and total ignorance of responsibility.

OBJECTS OF INTEREST IN PITTSBURGH.

One of the most attractive engineering features in Pittsburgh, and one which quickly catches the eye of any visitor who is taking a survey of the city from one of the bluffs, is the new "Point Bridge," as it is called, spanning the Monongahela River just above its confluence with the Allegheny, and opening a new thoroughfare to Birmingham. This handsome structure, recently erected by the American Bridge Company, of Chicago, was illustrated and described in ENGINEERING NEWS, Vol. III. page 220, so that we will refer our readers to the information there given, in place of repeating the details here. Suffice it to say that this bridge is a stiffened suspension, or what is known as Fidler's Patent in England, having a straight member, adapted to resist compression, extending from the top of each tower to the vertex of the suspension chain at the mid-span, and bracing between the two, the combination making an inverted, inclined, bowstring girder of one-half the span of the bridge. A critical discussion of this and kindred types of bridge was contributed to "ENGINEERING" by Mr. F. Claxton Fidler, within the last two years, the articles running, at intervals, through some four or five papers.

There were two points which struck us as objectionable about this particular bridge, and they were both matters which might easily have been attended to at the time. The suspension chains of some thirteen eye-bars, side by side, are very massive, and it is evident, on a near view, that they are intended to do the principal work of carrying the imposed load, while the straight members, of channel bars and plates with a much smaller cross-section, are intended to resist the distortion from a partial load. But the chains are painted of a dark color while the straight member is of a light shade, so that, on viewing the bridge from a little distance, the straight chord is the most prominent feature, and the chain appears to be subsiding. This is more especially the case when the side only of the aggregate of eye-bars which make up the chain can be seen. If the colors of these two members had been reversed, or they had been so painted as to effect the eye in proportion to their cross-sections, the effect would, as it seems to us, have been much improved. As to the other matter, we regretted to see the faces of the stones of the cut masonry in the anchorages marred by the holes where the *dogs* were attached for holding the stones while they were being hoisted and laid.

We were given to understand in Pittsburgh that the structure actually cost the contractors several thousand dollars more than the contract price, so that they may be excused from attention to some details which would have involved an increased expense without adding to the strength, and we would recommend this bridge as a desirable object for inspection by the profession, and as the pioneer structure of this type in the country. S. V. Albee, Photographer, of Pittsburgh, has some very large and fine views of the bridge. After one has satisfied his curiosity about this bridge, he is likely to be attracted by the new inclined plane, very recently opened to the public, and near its southern end. The Duquesne Inclined Plan is the newest of four inclined planes, all in Birmingham, opposite Pittsburgh, and built for the conveyance of passengers from the streets near the Monongahela River to the bluff some four hundred feet above. By such means the lands on the bluff are made available for residences. The experience of the people in this vicinity with the inclined planes connected with their numerous coal mines have accustomed them to and made them ready to patronize such contrivances as a means of communication, and experience has shown that they are safe.

The height of this plane is 400 feet, and the whole length is 792 feet; angle of elevation 30½ degrees.

The lower portion, 362 feet in length, is supported on wrought iron plate girders carried by iron trestles, one post being vertical and one perpendicular to the girder at each supported point. The highest iron trestle is 71 feet. The remainder of the plane is made with stringers on wooden posts. It has a double track and one car descends while the other ascends. Each car weighs 4½ tons, is 7 feet wide by fifteen feet in length, and has a level floor, the space below being utilized for a baggage or freight compartment, 6 ft. by 7 ft. The trucks and framework are of iron. The car is hoisted by a wire rope 1 ¼ inches in diameter, while a second rope 1 inch diameter runs by the side of the first to hold the car in case of a giving out of the other. The engines are 75 horse power, with two boilers, each 42 inches diameter and 24 feet long. The winding drum, of cast-iron, is 12 feet in diameter. The iron girders and trestles were built by the American Bridge Company, of Chicago; the machinery was built by J. & J. B. Mulholland, of Pittsburgh, and the steel cables were made by Broderick & Bascom, of St. Louis. The designs for the structure were made by Mr. S. Diescher, civil and mechanical engineer, of Pittsburgh, and the total cost of the work was $40,000.

THE present week closes with a record of lawlessness, crime, and anarchy throughout the country that is a disgrace to any civilized community. On the 16th inst. the fire-men and brake-men of the Eastern Division Baltimore & Ohio R. R., stopped work rather than accept the proposed reduction of their already low pay, by the Company, to take place on that day. The strike in itself was of no more importance than many similar ones, with which the railroad companies are familiar, but having been a very general reduction of wages of railroad employees throughout the country, resulting in consequent wide-spread dissatisfaction and discontent on the part of the lower class employees engaged in the making up and running of freight trains, and upon whom undoubtedly the last reduction falls very heavily, the time seemed to have come for a general outbreak on all the great transportation lines of the country, and therefore it is that we witness to-day such a sad spectacle of riot and bloodshed, resulting in the destruction of millions of dollars worth of property and a large number of precious lives; railroads and manufactories at a stand still, general business for the time completely paralyzed, and the municipal, state, and general government, engaged in the effort to quell the insurrection. At our present writing there is no freight being moved over any of the railroads leading to this city; on some of the roads the passenger traffic also is stopped and with it express and mail service; the principal manufacturing establishments are closed for want of help, or supplies, merchandise is piled up in the stores awaiting shipment, and business cummunications between the West and the Eastern cities is almost suspended. The original subject of complaint has in a measure been lost sight of and the contest is now between Capital and Labor, and around this as a war cry have gathered all the communists, thieves, thugs, and tramps, that prey upon society and who in the present crisis see an opportunity for indulging all their devilish instincts. As must always be the case in a country such as this, where the people do not depend for protection upon a standing army stationed in their numerous large cities, the present trouble finds the local authorities wholly unprepared to cope with it, but the appalling scenes at Pittsburgh and Reading and Buffalo have aroused the people to a full sense of the danger they are in, and we may confidently expect to see a speedy and effectual extinguishment of the present war, and the restoration of order and tranquility.

THE JAPAN LIGHTS.*

BY RICHARD HENRY BRUNTON, M. INST. C. E.

(*Continued from page 189.*)

The author accordingly thought it unnecessary to adopt extraordinary precautions in regard to the lantern or apparatus, when he felt it to be impracticable to use these in the construction of the towers; and the adoption of a reflector apparatus, and a lantern of small dimensions, offers many disadvantages.

1. The cost of a reflector apparatus, such as was sent

*Paper read before the Institution of Civil Engineers, London.

to Japan, is somewhat more than that of a dioptric apparatus.

2. The polishing of reflectors requires greater skill and attention than the cleaning of glass, and the liability to damage during the process is greater. This is an important consideration in a country where the lightkeepers are only partially trained, and of not very attentive habits.

3. The consumption of oil in reflector lights is about 25 per cent. higher than in dioptric lights in relation to the amount of light produced; and the consumption of wicks and lamp chimneys is greater.

4. The excessive heat given out by the flames in reflector lights impairs the ventilation of the lantern. In the first order lights, twenty-eight reflectors are used to transmit an equal light to every part of the horizon; and as in each there is an Argand burner, the accumulated heat from these renders a proper ventilation of the lantern a difficult matter. This is specially noticeable on fine summer nights.

5. The lowness of the lantern confines the air-space, and tends to increase the heat and to check ventilation.

The author therefore concluded that, while the risk of adopting dioptric apparatus was doubtful, its advantages over reflector lights were important; and he recommended that, for future lights, the ordinary dioptric apparatus, and the size of lantern in use in Europe, should be adopted. His recommendations on this point were finally approved and acted upon.

All the lanterns have been formed with diagonal astragals, similar to those adopted in the Northern Lights. They have been fitted with a cast-iron cornice-plate and sole-plate, to which the astragals, made of gun-metal are screwed. The roof is dome-shaped, and is double; the inner casing being made of No. 16 B.W.G sheet copper, and the outer of No. 14 B.W.G sheet copper. The ventilator on the top of the dome is of the same design as that used on the Northern Lights, having a couple of funnels, each covered by caps, surmounted by a hemisphere of copper, through which arrangement the heated air finds exit. Storm-panes are supplied to each lantern, and are provided with clip screws by which they can be attached to the lantern astragals, so that on the breakage of a pane they can be screwed in their places without delay.

Stevenson's holophotalized reflectors, adopted in the catopric lights, are parabolic, 21 inches in diameter at their mouth, with a spherical mirror at the back, and a lens, in front of the flames. The glass-work consists of a central lens, and four totally reflecting zones. These are made so that no light from the flame shall escape without being acted upon. The frames on which the reflectors are grouped have been constructed to carry two tiers of reflectors; those lights which show all round the horizon have fourteen on each tier. In fixed lights they are so arranged, that the axes of the apparatus on the upper tier fall midway between those of the lower tier; in this way insuring an equable light in every azimuth. In revolving lights the frames are made with from six to eight faces, and two or more reflectors are placed on each face. The frames are of wrought iron, and are fitted with brackets on which the reflectors rest, and which allow of the fourteen reflectors in fixed lights being placed round the circle.

The lightship lanterns surround the mainmast of the vessel. They are octagonal in shape, and are 5 feet in width from glass to glass, the daylight height being 5 feet 2½ inches. Ventilation is procured by eight tubes, on the roof, 3 inches in diameter, which are surmounted by a hemispherical cowl. There are also in the cornice-plate seventy-two holes, each 1 inch in diameter, and over these are sliding plates, with corresponding holes, while there are eight ventilators in the floor of the lantern. There are eight sets of apparatus in the lantern, each of which consists of a glass catadioptric apparatus in front of the flame, with a silvered spherical reflector behind it. The radius of the glass apparatus is 75 millimetres, and is made to embrace 180°. It consists of a central refracting belt, with one prismatic ring above and below, and above and below the prismatic rings are two catadioptric prisms. The spherical reflectors are 8 inches in diameter, and are of silvered copper. The apparatus is hung in swinging gimbals, which allows of its remaining plumb during any movement of the ship under 30°.

The dioptric apparatus, adopted in the latter lights is the ordinary Fresnel design, with all recent improvements. The first order fixed apparatus has a cylindric refractor, consisting of a central belt, with six prisms above and below it. There are eighteen catadioptric zones above the refractor and eight below it. The glass-work was put to the usual optical tests, by Messrs. Stevenson, before being taken off the manufacturer's hands.

The oil burned in the lighthouses has been, up to within a recent period, imported from China. The manufacture of oil in Japan is limited, and although some Japanese oils are good, no dependence can be placed upon getting a regular supply of any of these. One oil from China, procured from a nut, is a good burning oil, but its supply is uncertain, and its price often rose so high as to make its use almost prohibitive. Another Chinese oil, made from beans, is always to be had in large quantities, and its price is moderate, but its quality is variable, and under the most favorable circumstances, it does not give satisfactory photometrical results. The supply of the vegetable oils of the necessary quality being therefore doubtful, the author deemed it advisable to recommend the adoption of mineral oils, and sanction was given to this in November, 1872.

The burner invented by Captain Doty was selected. It is claimed for this burner, that it consumes a smaller quantity of mineral oil than the ordinary Argand burner does of vegetable oil, and that it produces a most powerful light; —that, "volume for volume, mineral oil is superior to colza oil to the extent of one-fourth more light in the first order lamps, two-fifths more in the second, one-half more in the third, and four-fifths more in the fourth order lamps;"—that the flames are more easily attended to, and the standard heights of these more readily obtained;—that mineral oil is not affected by cold, and that it may be used without danger in hot weather;—that the same lamp-chimneys and wicks can be employed for burning mineral oil as for vegetable oil, and that the burners can be applied with ease to all existing lamps. Practical experience, afforded by the working of the Doty burner in Japan, bears out, to a great extent, these statements. The best result attained in an ordinary Argand lamp, with the oils formerly used, was a flame equal to ten standard sperm candles. There was aways a difficulty in maintaining this standard, snuffing and trimming being necessary once, or sometimes twice, during the night. The Doty burner in the same lamp, gives a flame equal to eighteen or twenty candles, which burns steadily, and generally without requiring any touching during the longest nights. The consumption of oil depends very much upon the skill of the lightkeeper. It is quite possible to cause an unnecessary consumption by the want of proper regulation of the ventilation in the lantern. The consumption has, therefore, varied considerably; but this difference will no doubt disappear as the lightkeepers get more accustomed to the use of the oil. The fitting of the Doty burner on the existing lamps was carried out with little expense or trouble. But the flame produced by the Doty burner, while exceedingly pure and brilliant, emits a much greater heat than that from a vegetable oil flame. The breakage of lamp-chimneys has on this account increased considerably. In the reflector lights of the first order, where there are in some cases as many as twenty-eight lamps in one lantern, the heat is, in certain states of the weather, very high and productive of great inconvenience. It is no uncommon thing for the temperature inside the lantern to be 130° Fahr., when that outside is 85°. This is the only real objection to the Doty burner in Japan, but there can be little doubt that it is capable of remedy by increased ventilation.

The mineral oil principally used up to the present time has been Young and Co.'s paraffin oil. It was procured direct from the works at Bathgate, and was imported in iron drums, each containing 5 gallons. Its cost, delivered in Yokohama, including all charges, was 75 cents per gallon. The specific gravity of this oil is 810, water being 1,000, and it does not emit any inflammable vapor until heated up to 145° or 150° Fahr.

Different samples of American kerosene have been tried. Its market price in Yokohama varies from 45 to 60 cents per gallon; but no specimens have been found of sufficiently good quality to warrant its use in the lighthouses. Its specific gravity ranges from 760 to 790, and many specimens had a flashing point as low as 80°. The best which was tried gave 120° as its flashing point, but it was consumed in a Doty burner, at 25 per cent. greater rapidity than the paraffin oil, and is altogether unreliable.

Petroleum exists in Japan in large quantities, and many wells have been sunk by the natives in different parts of the country, But no measures have yet been taken for carrying out the necessary refining processes, so as to enable it to be used either for domestic or lighthouse purposes.

The principal office of the Lighthouse Department is at Yokohama. The workshops, store-rooms, etc., are erected on a space of about 4 acres of ground, and form a complete establishment, where the whole work required in the construction and maintenance of the lighthouses, lightships, and buoys, has been carried on. The yard is on the seashore, and is provided with a stone jetty alongside of which boats can lie. On this is placed a crane capable of lifting 5 tons, and a line of rail runs from it to the different store-rooms.

In the yard there is an experimental lighthouse, a brick building, 20 feet square and 40 feet high. There are three floors, the lower one being used for testing oils, trying the power of flames, repairing or re-adjusting apparatus, or doing such other experimental work as may be required. The second and third floors are used for the purposes of the lighthouse. The lantern was entirely constructed in the lighthouse yard, and is of the ordinary size for the first order lanterns. The different floors are fitted with trap-doors, sufficiently large for the largest apparatus to pass without being taken to pieces. The principal object of the lighthouse is to afford means for furnishing a preparatory training to young Japanese lightkeepers previous to their being sent to the regular lighthouse stations. It is also used for examining apparatus, which, during its voyage from England, may have got shaken out of adjustment, or have been otherwise damaged. The mineral oil store, built of concrete, with walls 2 feet thick, and an arched roof of brick, is capable of containing 30,000 gallons of oil, in the boxes in which it usually comes from England. There is also a vegetable oil refinery, with the boilers, agitators, and vessels necessary for settling and filtering the oil. Everything connected with the lighthouses, with the exception of the optical apparatus and lanterns, has been constructed in the establishment. The two lightships were built, fitted out, and entirely completed in the yard; twenty-two buoys were made, and the iron and wooden lighthouses were fitted previous to being sent to their destination.

The whole work has been carried on with the help of two assistant engineers, Mr. James McRitchie, Assoc. Inst. C. E., and Mr. S. Fisher. One secretary and two clerks were also attached to the establishment. The other Europeans engaged in the service at different times were: one superintendent blacksmith, two inspecting and repairing artisans for the apparatus, one plumber and coppersmith, one shipwright, four masons, and fifteen lightkeepers.

The Japanese staff is presided over by a commissioner, with two assistant commissioners acting under him. These are granted certain powers by the Public Works Department of the Government, and they are supposed to work in concert with the chief Europeans in the office. But, in point of fact, they are vested with the supreme control, and the Europeans have little or no authority. Under the Commissioners there is a staff of fifty-three Japanese officials, who are divided among four departments, viz: the secretary's, the accountant's the building or construction, and the storekeepers departments. The organization of the office was arranged so as to serve the peculiar requirements of the service. The author compiled from English, French, and American sources, one book of instructions for lightkeepers and another for repairing artisans. These were translated into Japanese, and are closely adhered to. The former gives minute directions regarding every process in connection with the lights, and orders meteorological records to be kept at each station. The latter explains the adjustment necessary in the apparatus, and the manner in which repairs are to be carried out.

The European lightkeepers are, distributed among the most important lighthouses, but their numbers are being gradually reduced, as the Japanese become more expert and efficient. The Japanese lightkeepers num-

ber one hundred and two, but only a few of them are sufficiently advanced to have charge of a light, the remainder acting as assistants under the Europeans. There are generally four Japanese at each station under the European, one of whom is principal, the remaining three being pupils in the course of training. The European lightkeepers have authority to demand obedience from the Japanese in any manner connected with the keeping of the lights, or the general good order of the station, but they have no further control over them; and the execution of repairs, procuring stores, or the making of any payments is done through the Japanese principal lightkeeper. The Europeans are specially directed to be attentive in instructing the Japanese lightkeepers, and rewards are held out to those who succeed in training the most efficient men.

Each lighthouse is inspected, on an average, three times every year by one of the Japanese commissioners, accompanied by one of the engineers. The only ready means of communicating with most of the lighthouses is by sea; and the vessel procured for carrying on the work of inspection is a paddle-wheel steamship of 489 tons register at 370 nominal HP. She is easily handled in confined harbors, of great power, and capable of steaming out of danger under any circumstances, with a capacious deck for buoys, and the necessary passenger and cargo accomodation. She is commanded and officered by Europeans, but her crew consists of Japanese only.

Owing to the manner the Japanese keep accounts, and their desire to have the whole control of the expenditure, the author, notwithstanding the utmost efforts, has failed to preserve a correct record of the works. For the first year a system of certificates was instituted, by means of which he had a check upon all monies paid; but he soon discovered that many payments were made by the Japanese officials without any certificate, and the practice had to be abandoned as useless. He has further been in partial ignorance of the prices paid for material and labor. The statement in Appendix II., of the money expended in the construction and maintenance, of each lighthouse, has chiefly been supplied by the Japanese officials.

APPENDIX I.

List of Lighthouses, Lightships, Buoys and Beacons on the Coast of Japan.

LIGHTHOUSES.

1. Shinagawa, Dioptric, red, fixed, 5th Order.
2. Yokohama Harbor, Dioptric, red, fixed, staff light.
3. Haneda, Dioptric, green, fixed, 4th Order.
4. Kannonsaki, Dioptric, white and red, fixed, 3rd Order.
5. Tsurugisaki, Catoptric, white and red, flashing, 2nd Order.
6. Noshimasaki, Dioptric, white, fixed, 1st Order.
7. Inuboyesaki, Dioptric, white, revolving, 1st Order.
8. Kinkasan, Dioptric, white, fixed, 1st Order.
9. Siriyasaki, Dioptric, white, fixed, 2nd Order.
10. Awomori, Dioptric, red, fixed, staff light.
11. Ishinomaki Dioptric, white, fixed staff light.
12. Noshiaf, Dioptric, white, fixed, staff light.
13. Nemuro, Dioptric, red, fixed, staff light.
14. Jokashima, Dioptric, white, fixed, 5th Order.
15. Mikomoto, Catoptric, white and red, fixed, 1st Order.
16. Irosaki, Catoptric, red, fixed, 6th Order.
17. Omaesaki, Dioptric, white, revolving, 1st Order.
18. Sugashima, Dioptric, white, fixed, 4th Order.
19. Matoya, Dioptric, white, revolving, 4th Order.
20. Kashinesaki, Catoptric, white, revolving, 2d Order.
21. Shiwomisaki, Catoptric, white, fixed, 1st order.
22. Tomagaishima, Dioptric, white fixed, 3rd Order.
23. Temposan, Dioptric, white, fixed, 4th Order.
24. Wadanomsaki, Dioptric, red, fixed, 4th Order.
25. Yesaki, Catoptric, white, fixed, 1st Order.
26. Nebeshima, Dioptric, white, fixed, 3rd Order.
27. Tsurishima, Dioptric, white, fixed, 3rd Order.
28. Hesaki, Dioptric, white and red, fixed 4th Order.
29. Rockuren, Dioptric, white, fixed, 4th Order.
30. Kadoshima, Dioptric, white, flashing, 1st Order.
31. Shirasu, Dioptric, red, fixed, 5th Order.
32. Yeboishima, Dioptric, white, fixed, 2nd Order.
33. Iwoshima, Catoptric, white, fixed, 1st Order.
34. Satanomisaki, Catoptric, white, fixed, 1st Order.

LIGHTSHIPS.

35. Yokohama Bay, Catoptric, red fixed.
36. Yakodate Harbor, Catoptric, white, fixed.

Of these thirty-six lights there are ten first-order, four second-order, four third-order, seven fourth-order, three fifth-order, one sixth-order, five staff lights, and two lightships.

BUOYS.

1. Can buoy, 8 ft. high; south of Yokohama Harbor.
2. Can buoy, 8 ft. high; north of Yokohama Harbor.
3. Can buoy, 8 feet high; On Kawasaki Spit, Gulf of Yedo.
4. Can buoy, 8 feet high; On Rawasaki Spit, Gulf of Yedo.
5. Nun buoy, 8 feet high; On Saratoga Spit Gulf of Yedo.
6. Can buoy, 8 ft. high; On Kanabuse, Shimonoseki Straits.
7. Can buoy, 8 ft. high; On Middle Ground, Shimonoseki Straits.
8. Can buoy, 9 ft. high; At Hikashima, Shimonoseki Straits.
9. Hollow-bottomed buoy 9 ft. high; At Hikushima, Shimonoseki Straits.
10. Hollow-bottomed buoy, 9 ft. high; At Hikushima, Shimonoseki Straits.
11. Hollow-bottomed buoy, 12 ft. high; At Hiraiso, near Awaji Sima.
12. Hollow-bottomed buoy, 12 ft. high; At Motoyama in Inland Sea.
13. Hollow-bottomed buoy, 12 ft. high; North of Island of Ainoshima, west of Shimonoseki Straits.

BEACONS.

1. Stone beacon, 20 ft. high; On Manaita Rock, Shimonoseki Straits.
2. Stone beacon, 20 ft. high; On Narusi Rock, Shimonoseki Straits.
3. Stone beacon, 20 ft. high; On Yodsibi Rock, Shimonoseki Straits.

(To be continued.)

THE SHAPING OF TOWNS.

NO. II.

One of the most serious inconveniences that men are subjected to in our large cities is the necessity of traveling long distances, and spending a great deal of time between their homes and their work. For the New Yorker, for instance, whether he takes a ferry-boat to Brooklyn or Staten Island, or a horse-car to an uptown house, or a steam-train to a suburb up the river, an hour each way is the least time he must allow for his daily transit. New York is the worst of our cities in this respect, and there the waste of time and annoyance thus caused have long been a matter of great complaint, and its remedy of eager discussion; but others of our towns are not greatly better off. To wealthy men whose business does not press them very hard, and who are willing to pay for the charms of a suburban life, the burden is not so great; but to the greater part, who must be at their business pretty early, and make a long day, it is a heavy one. The endeavors that are made to meet the difficulty are all in the direction of quickening the transit, a thing for which thus far no satisfactory means have been found. For cities which are already in this trouble, there is apparently no other relief; but for those which have their growth before them, it is important to consider whether there may not offer some natural ways of avoiding it.

In some cities, of which Paris may be taken as the type, the difficulty is avoided by superposing residence and business premises over pretty much the whole territory, so that there is always a home to be had in or near any quarter to which one's occupation may lead him. It has been the English and American habit, however, to keep the commercial and the residence quarters of a town distinct. In many busy towns this is in some degree a necessity of their sites, but it is also the result of a strong sentiment, so strong in fact that wherever in an American city business gets a foothold upon a street or square, the better class of residents, those who hold to the English tradition of a house to themselves, flee before it as from a pestilence, leaving between it and them a neutral zone of boarding-houses. For people of this temper it is an essential condition in the arrangement of their towns that the residences and the commercial quarters shall be distinct. When there is no natural barrier the tendency of business is to spread itself out thin, and cover a good deal of ground in every direction, so driving habitations far on all sides from the centres of business. We are in the habit of tacitly assuming that any thing which checks or confines this tendency in any direction must necessarily be an injury. Yet it may happen that a barrier which offers some check to the spread of business quarter in one direction, if it does not fence it to inconvenient crowding, will on the whole be an advantage to a town both by compacting its business into close compass, and by resisting its tendency to drive dwellings into the distance.

One means of combining at once proximity and ease of communication with distinct separation between places of business and dwellings, and a means which is in many respects the most convenient of all, is a difference of level. It is the means, in fact, which secures insulation between house and business with the minimum of distance. This insulation is got artificially in Paris, and in other cities of like arrangement, by reserving the one or two lower stories of the buildings over the greater part of the city for shops and offices, and the upper stories for dwellings which have no connection with the business premises below, so that such cities are stratified, as it were, in commercial and domestic layers. This arrangement is very serviceable, perhaps the most serviceable on the whole, in large towns which have no marked difference of level in their natural situations. It is, however, not in accordance with any habits yet formed in American or English communities; and in a great many towns there are natural differences of level that may be availed of to secure the kind of insulation which Englishmen and Americans prefer, that is, an actual separation of quarters as well as premises, with almost as great proximity as the other system gives. A tolerably abrupt elevation, for instance, of some fifty or sixty feet, or even less, may prove as effectual a barrier as a mile or two of level distance; even more effectual, because more permanent, if it rightly employed. Such an elevation, high enough to lift the houses on it well above the building below, may be compared in its convenience to a promontory or cape running out into deep water. It may, of course, be so placed as to be only an impediment and a disadvantage; but where there is room enough for growth and communication, the bluff that constrains its business plain on one side may be in the end as real a convenience to a town as the water-front that confines it in another. The one, however, being an obstacle which challenges removal, the community is apt to attack it as soon as any of its inconveniences are felt, without waiting for a considerate weighing of its advantages and defects. A strip of elevated land a mile long and half a mile wide, bordering upon the commercial region of a city, might with a proper distribution of inhabitants provide fifteen or twenty thousand people with house-room, where the men of the families could, on an average, walk down to their places of business in ten minutes. Fifty feet of rise would lift this platform above the danger of invasion of trade, while stairs and inclines would make it accessibile to foot passengers in a minute or two, and a circuit of only a quarter of a mile would be enough to lift carriages and wagons to double the height.

A great difficulty in the way of this convenience is the unreasoning prejudice against ups and downs. The very man who would think it fortunate to have a house within a mile of his counting-room, and would disregard the hundred feet which his road might rise in that distance, would be very ready to set the pick and shovel at work upon an elevation of a third the height if it lay directly before him, without stoping to thing of the mile or two of distance it might save him if he would climb to its top and dwell there. Our forefathers prized such situations and seized them as vantage-grounds; but to us they are intolerable, and exist only to be levelled. All this is at the very time when we are beginning to think nothing of carrying our buildings a hundred or a hundred and twenty feet into the air. The same use of elevators which make this sort of building worth while will provide an easy way of overcoming differences of level in streets or squares for the weak-kneed or the indolent. It is not altogether a disadvantage that the routes for carriages and traffic have, in such a case, to be separated from those of foot passengers. The circuit of a quarter or a half mile which would be required simply to overcome a height would probably, at first suggestion, appear an intolerable nuisance to a people impatient of circuitous routes; but the same length of road and difference of level between distant points would seem a trifle.

When we leave the points of convenience for business and residence, and turn to salubrity, we find many things in favor of variety of levels in towns. Not only do slopes and elevations give advantage in respect of light, air, and outlook to the houses, but they tell greatly in favor of cleanliness, and of the ventilation and disinfection of streets. We have one large city, Baltimore, in the United States, which prides itself on the surface drainage which its uneven area secures for it, to that de-

gree that it neglects to provide itself with sewerage. Whatever may be thought of this choice, it is clear that if a hilly town can do better than a flat one without subterranean drainage, it has equally the advantage over it, that its sewers will keep cleaner and deliver their contents more freely, and also that the surface of the streets will be more easily cleansed, whether naturally or artificially. Moreover, by providing shafts in the elevated points, the cardinal need of ventilating the sewers can be met to the best advantage. The one public service which is liable to be much impeded by irregularities of level is the water-service, to which elevations are often a difficulty. Nevertheless the introduction of standpipes and high service supplies have overcome this difficulty in all cities where it has been felt to be serious.

We are far from arguing that inequalities of site are necessarily in all cases a blessing. This would be as unsafe as the converse notion we are combating, that they are necessarily a disadvantage. But we wish to draw attention to the fact that they often have great advantages, and so far from being looked upon instinctively as enemies, to be got rid of if possible, as we Americans do commonly look upon them, they should be carefully scrutinized for the benefits they may offer, and with the understanding that they may prove to be the best of friends. It is not to be imagined that the inhabitants of Edinburgh or Genoa would find the convenience or comfort of their cities enchanced, or that any thing but regret would follow, if the heights that engirdle and diversify them were levelled. Yet if sites of equal promise were now occupied for the first time, it is only too likely that the instinct of the day would lead to their being degraded into something as near flatness as engineering could secure, with sacrifice of their native convenience, as much as of their beauty. We have not spoken of the question of beauty, because this is one on which there can hardly be two minds, and because it is beside our present discussion. But the questions which do not bring their decision as a matter of course, and in which it seems to us the notions that commonly influence people are not well considered. It is a misfortune that questions of business and residence should be so habitually studied apart as they are. In respect of comfort as well as of beauty, they ought to be regarded as parts of the same problem; and the best total result is not to be obtained by giving either of them undisputed and unmodified predominance. The problems which they bring up are problems which concern all people, but which architects by virtue of the bearings upon them of their professional work have especial reason to consider, as by virtue of their training they have special opportunity to study them. In a matter in which not many people have clear convictions, the few who have them may often exercise a controlling influence; and though democratic communities are not apt to make their towns to order, and it is not easy to compel the direction of general growth when every one is his own master, it may be in the power of architects by vigilence and intelligent advice to save a good deal not only of disfigurement, but of more practical injury, to the towns with which they are concerned. — *American Architect and Builder.*

DRINKING-WATER AND ITS IMPURITIES.

The intimate connection between the purity of the water-supply and the health of cities and towns has come to be universally recognized in official quarters; and though the legislation upon this subject may not in every instance directly result in the establishment of the proper safeguards against the pollution of the sources of supply, it has, beyond question, been of incalculable benefit in effecting a very general improvement in the sanitary condition of our communities.

The determination of the wholesomeness or unwholesomeness of a sample of water is, however, by no means an easy matter, since taste, smell and color do not always constitute infallibe tests of its qualities; for though we may reject as unfit for use waters that contain visible impurities, or that possess a disagreeable taste or odor, these are in many cases comparatively harmless compared with others that give no outward indications of danger that may be detected by the senses, but which are nevertheless, contaminated by those most insidious of poisons, the germs of pestilence and infectious diseases. So that, contradictory as it may appear, a perfectly limpid water, free from disagreeable smell or taste, may be infinitely more dangerous to health than another that is obviously offensive to the eye and disagreeable to the taste and smell. This apparent contradiction, however, does not alter the fact that, in a general sense, a good drinking-water should, *a priori*, be clear to the eye, pleasant to the taste, and free from offensive odor.

Perfectly pure water does not exist in nature, although rain-water is so nearly pure that we may consider it so for all practical purposes; but such are the solvent powers of water that it may be said to take up more or less of every substance with which it comes in contact. Hence it is that water that has penetrated for a considerable distance into the soil and through crevices of the rocks, and subsequently makes its appearance upon the surface in the form of springs, through artesian wells, etc., is generally more richly charged with mineral matters than the surface-waters of rivers or shallow wells. Such mineral constituents, which commonly consist of the carbonates, sulphates or chlorides of lime, magnesia (iron), soda or potassa, are not to be considered as notably injurious to the health when present at slight quantities, as is generally the case; and were these the only impurities that affected our drinking-water, they might be practically ignored. The surface-waters—lakes, rivers, etc.—from which the water supplies of most cities and towns are obtained, are peculiarly susceptible to quite a different species of contamination, which is productive in many cases of such pernicous results to the health of communities as to have very properly elevated the question of the purity of the water-supply of cities and towns to the first rank amongst sanitary considerations. We refer here to the pollution of rivers, etc., with animal excreta, to the effects of which medical men are unanimous in ascribing the occurrence of typhoid fever, dysenteric epidemics, etc. This is no mere opinion, founded upon the *ipse dixit* of authority, but a strictly legitimate inference from a legion of observations, in which the relation between cause and effect has been ascertained beyond the possibility of a doubt.

In considering the question of purity of the water-supply of cities, we are confronted with complications of a special character—the refuse of gas-works, dye-houses, the dangers of lead pipes, and the like—but these are altogether of secondary importance when compared with the one above named. It is most fortunate, therefore, considering the almost universal practice which prevails in this country of discharging sewers, laden with the refuse of large communities, into running streams, which further down are drawn upon to supply other cities and towns upon their banks with water, that Nature has herself supplied an efficient remedy for what would otherwise prove to be a most pestilential evil, in that she has given to the rivers the power of self-purification. The running water, by constantly bringing fresh portions of its load of impurities into contact with the atmosphere, rapidly causes its destruction by oxidation, so that a river that has received the sewage of a city will, under most circumstances, be pure enough to drink a few miles below it.

We do not wish to be understood as affirming that the pollution of rivers, etc., with sewage is to be regarded with indifference, for we have always maintained that it was highly uncivilized to waste in such disgraceful fashion vast quantities of matter endowed with fertilizing virtues of the first order, while its utilization does not involve insurmountable difficulties.

Of the artificial means of purifying water, the simplest and best is filtration, which is in some places carried out on a grand scale by means of beds or reservoirs provided with porous partitions, or so arranged as to oblige the water to percolate in succession through a variety of cleansing materials. By means of such devices all suspended impurities, such as mud, animal and vegetable substances, etc., are strained out, and such a devices are held in deservedly high estimation.—*The Polytechnic Review.*

CORRESPONDENCE.

ALTON, ILLS., *July 20, 1877.*

EDITOR ENGINEERING NEWS.

SIR.—The Alton Water Works Company have just completed and are using an Elevated Wooden Tank of 40 feet diameter and 24 feet deep, with its bottom set 25 feet above the highest ground in the city and 260 feet above the pumping machinery, with which it is connected by ¾ mile of 16 inch and 10 inch cast iron pipe. This new tank is designed as an auxiliary, to one 30 feet diameter and 16 feet deep set 32 feet high and built one and one-half years since, whose capacity was insufficient for the domestic consumption and required to be filled twice in 24 hours.

The capacity of both Tanks is 300,000 gallons; the amount used daily averages 160 to 175,000 gallons, or three and one-half hours work for the pumping machinery per day, which is managed and run by one man with banked fires for 20 hours out of 24, instead of constant firing and two sets of attendants as direct pressure in the mains by machinery requires. The latent heat of the water is carefully confined in these Tanks, which are rendered frost-proof on top and covered with shingle roofs, like modern Railway Tanks; during the continued cold of last winter, ice in the Mississippi river was 16 inches thick, but there was no ice at any time in the small Tank, whose elevation is sufficient to throw fire streams out of nearly all the 85 fire hydrants set on 9½ miles of water mains. Advocates of Iron Stand Pipes will say that such wooden structures are perishable; but we have examples of stand pipes freezing, bursting and blowing over, and a comparison of cost and efficiency between a stand pipe of 7 feet interior diameter and 200 feet high, holding from top to bottom less than 60,000 gallons and costing $24,000 and a wooden Tank holding 200,000 gallons and set 100 feet high costing $8000. or set 200 feet high costing $10,000, shows that errors of judgment in engineering are still common.

There are many examples of compound wooden structures standing 50 and 75 years and still doing heavy service, showing the skill and fidelity of their constructors, whilst many others unskilfully designed and executed serve to throw discredit and loss on their projectors.

HARRY TAYLOR,
Eng. and Supt. Alton Water Works.

HOTEL CARS.

For some time we have heard hints of a line of hotel cars for the Omaha and California line of the Chicago & North-Western Railway. When asked about their cars, the officers have uniformly evaded a direct reply. Our "reportorial instinct;" taught us to investigate for ourselves. We have done so, and are now enabled to state *positively* that such a line will be started in the early spring, and that the cars are now being built. The fact will no longer be a secret after this day's paper gets before the public.

Four of the most magnificent hotel cars that have been built *anywhere* are now being constructed by the Pullman Palace Car Company expressly for this line. These cars will be sixty-six feet long, ten feet wide, and ten feet high, with twelve sections, one drawing-room (with table room for six persons), and one state-room, besides the kitchen, china closet, dressing-room, etc. The interior will be finished with black and white walnut, mahogany, French ash, and curled maple, the place of the usual head-lining being filled in with foreign polished woods; the panels between the windows will be of California laurel and other California woods; the lamp fixtures, window fastenings, door hardware, etc, will be of triple plated silver. The upholstery of the seats is to be of rich and plain reps, corresponding and harmonizing with the wood finish of the sides and roof of the cars. Between each set of seats is space for a table that will accommodate four persons comfortably, but as a rule are not expected to seat more than two persons. The glass and chinaware for the tables are now being made at Dresden, Germany, from patterns selected from the Royal Dresden exhibit that was at the Centennial Exposition and so greatly admired. Each piece of silverware, glassware and chinaware will have the monogram of the Chicago & Northwestern road marked thereon. The kitchens of the cars will be so arranged that no fumes from the cooking viands can reach the occupants of the berths. On each car will be a steward, two cooks, three waiters, and a chambermaid to wait upon lady patrons. It is the intention of the company to furnish the best meals that money can buy, and choice wines and cigars will be attainable by those desiring those luxuries.

These hotel cars will leave Chicago on the "California Express," and run through to the Missouri river. On the west-bound train, dinner, supper and breakfast will be served. The east-bound hotel cars will leave Omaha on the "Atlantic Express" each day, in the afternoon. On this train supper, breakfast and dinner will be served. Thus passengers bound in either direction will be enabled to have all their meals *en route* and yet not leave their palatial traveling parlor.

The only objection that has ever been raised against the use of hotel cars has been connected with the odors of the kitchen. As we said before, this, in these cars, will be entirely obviated; no person, no matter how peculiar he or she may be, will have cause to make any objections on this score. In the dining car you merely get your meals, and as soon as you are through eating you are shoved out and started for the coach or sleeper, so as to make room for some other traveler who desires your place. While in these hotel cars your berth will be secured through, you will own it absolutely for the length of your trip, and it will be your own for lounging, sitting, sleeping, and eating purposes, as much as your own seat in your own house. As it is not generally known, dining cars are never run over the entire length of any route; they are taken on and set off of the train at stated meal times, while these hotel cars will be made a part of the train and run through in the same way as the regular sleeping car.

On the admirable steel rail that is now laid on the Chicago & North-Western Railway, these elegant, sixteen-wheeled hotel cars will ride as easy and with as little noise or oscillation as a balloon that floats serenely through the air; and we believe it will be found to be a result that thousands will flock to this "Pioneer Line," who have hitherto gone by some other route.

With these and other improvements the people of Cedar Rapids are very largely interested and we believe will join with us in congratulating the progressive management of this great line in this its most advanced step; and unite with us in saying, the Chicago & North-Western Railway has become the foremost road in all the West.

These hotel cars will be placed in service about March 1st, 1877.—*Republican, Dec. 22, 1876.*

Last year in England 1,249 persons were killed on the railroads, while 1,528 were killed by carriages and wagons.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

Byron, Ills., was recently granted an appropriation of $12,500, by Ogle county, to build a bridge.

The Ohio Bridge and Iron Co., at Lancaster, Ohio, has contracts for nine highway bridges and its works are busily employed.

The board of directors of the St. Louis air line have instructed the president to proceed forthwith with the construction of the Wabash bridge.

The citizens of Sterling, Ills., will vote on the 11th of August, upon the question of taxing themselves to the amount of $40,000, for the purpose of building a free bridge across Rock River.

Geo. Paul, C. E., of Cuyahoga Falls, Ohio, has recently completed drawings for the new Monroe Falls bridge in Summit county, Ohio. The iron superstructure in two spans, has been let to the King Iron Bridge Co., of Cleveland at $12 per foot.

At Kent, Portage county, Ohio, the county authorities are constructing a stone bridge composed of three arches, the full width of the street. The stone, a fine grained sand-stone, is found in large quantities in the vicinity. The work, which is to cost about thirty thousand dollars, is to be completed this season.

Judge Drummond issued an order week before last to the I., B. and W. Railroad Company, to build the bridge across the Illinois river at Havana. Some arrangements have been entered into between the I., B. and W. and Springfield and Northwestern R. R., whereby the former company will build the bridge and use the S. and N. W. track, thus giving them an outlet west of the Illinois river.

The Lansing (Mich.) *Republican* says: "Two bridges built at Adrian by the Canton Bridge Company, have been examined by Prof. Davis of the engineering department of the university, and pronounced faulty in many respects and not built according to contract. They will not be accepted, and lively times are coming. The same company has received about $60,000 for 11 bridges at Lansing, and four of them have gone to meet Noah's ark."

The Pittsburgh and Lake Erie R. R. Co., having lawful authority to erect a railroad bridge over the Ohio River at Beaver. Pa., on the line of said road, through their president James I. Bennett, Esq., of Pittsburgh, Pa., gave notice that on the 27th inst. they would submit to the Secretary of War, for examination and approval, plans of said bridge, and a map of the location thereof; the proposed bridge having a span over the main channel ninety feet in height above low water.

RAILROADS.

The Cincinnati Southern railroad was opened for business on the 23d inst.

The last rail on the Vermont division of the Cortland and Ogdensburg Railroad was laid on the 17th, completing the connections with the West and the Canadas.

About three-fourths of the stock necessary to build a railroad from Scottdale to Mt. Pleasant, Westmoreland county, Pa., has been subscribed, and the right of way is being secured, with every prospect of success.

A surveying party has started from Stanton to Cedar Lake, Mich., to lay out the extension of the Detroit, Lansing & Northern R. R., a distance of ten miles. It is intended to have it completed before snow flies.

It is reported that the Southern Pacific R. R. Company have engaged a quarter of a million eucalyptus trees. The company will plant the trees along the line of their track, and will use the timber when sufficiently grown to replace the ties as they wear out.

An agent is out securing the right of way for the Chicago and Alton company's Missouri extension, known as the Kansas City, St. Louis & Chicago R. R. He is authorized to bind the railroad company to build the railway and have it in condition for the running of trains before January, 1879.

A large meeting of citizens of Preston county, West Virginia, was recently held at Kingwood, at which a committee was appointed to confer with the people of Monongahela county relative to the building of a narrow-gauge railroad from the town of Morgantown, via Kingwood, to a point on the Baltimore & Ohio R. R.

The San Juan Railroad has filed articles of incorporation at Denver, Col., to run from Fort Garland, the present terminus of the Denver and Rio Grande Railroad, to Salt Lake City, via Del Norte, Rio Grande valley, the valleys of Clear Creek, Santa Fork, Gunnison, and the Grand river's branches, to Ouray, Eureka and the Animas valley. The capital stock is $1,500,000. President H. B. Greeneough; Secretary and Treasurer, H. A. McIntyre.

The Pittsburgh *Leader* in an article concerning the recent organization of a company for the building of the Pittsburgh & Lake Erie Railroad, a project that has been before the public for a considerable time, says: "Pittsburgh is to be asked to subscribe $600,000 toward this enterprise, which being done the management will at once proceed to lay the track between that city and Youngstown, O., a distance of about 70 miles. The road will run down the south side of the Ohio as far as Beaver, where the river will be bridged. An extensive farming district will be afforded an outlet. The whole left bank of the Ohio is filled with extensive coal fields, which will in the future be operated with advantage. As a rule the grades on this route are almost level. The maximum grade amounts in four places to only 25 feet per mile. A branch will run to New Castle, at which point it will connect with the New Castle and Franklin Railroad for the oil regions, Erie, etc. Besides giving Pittsburgh a competing line to those points, it connects the Baltimore & Ohio road with the roads mentioned. At Youngstown it will connect with the Lake Shore Railroad for Astabula harbor, with P. & Y. (narrow gauge) for Painesville harbor, and with Atlantic & Great Western Railroad for Cleveland direct, and by these to Chicago, Detroit, Milwaukee, St. Louis and the Pacific States, and the entire West, and by way of Meadville and Buffalo to the northeast and Canada." It is estimated that the new road can haul 40 loaded cars, against from 15 to 17 on the Cleveland & Pittsburgh Road. The new management is composed of well known Pittsburgh capitalists and business men and the success of the enterprise seems assured. As will be seen in another column of our journal, the company give notice of their intention to bridge the Ohio River, at Beaver, Pa., on the line of their proposed road.

GAS AND WATER-WORKS.

The city of Indianapolis has cut off 150 fire plugs. The Water-works Company will sue, claiming a breach of contract.

Mr. J. T. Foster has been appointed Superintendent of the water works of the towns of Lake and Hyde Park, Ills.

All the Danville (Ill.) newspapers are opposed to that city running in debt to construct waterworks. The question will be put to a vote of the people.

Paris (Ill.) has waterworks fever, and her council has been to Alton to investigate the works there. They returned impressed with the belief that waterworks could be established in Paris for $30,000.

The citizens of McKeesport, Pa., voted on the 17th inst., on the water works proposition. About five hundred votes were cast, and there was a majority of one in favor of erecting the new works.

Monticello, Iowa, is going to have waterworks. The company constructing the same is known as the Monticello Artesian Well Co. Articles of incorporation of which were adopted on the 23d ult.

Dennis Long & Co., of Louisville, Ky., through their agent, Mr. A. A. Guilford, of Chicago, have recently completed putting in a number of mains and hydrants for the waterworks at Winona, Minn.

C. G. Hildreth, Secretary and Treasurer of the Holly Manufacturing Company, of Lockport, N. Y, and Mr. Allyn, of the Norwalk, (O.) Water Works, inspected the Evanston Ill., Water Works, Wednesday of last week.

A meeting to consider the question of putting in waterworks upon the Holly system, was recently held in Oxford, Mich. It is stated that an estimate calling for $7,000 was presented, which scared the citizens and no conclusion was arrived at.

Messrs. Sherman, Flagler & Babcock, of Troy, who have contracted to put in the new waterworks at Gloversville, N. Y., are pushing the work rapidly forward. A large amount of the iron has already arrived, and the work is to be entirely completed by the 1st of November.

The engineer in charge of the St. Catharine's, Ont, water works reports that $50,000 more will be required to complete the system of waterworks now in process of construction in that city, which, if the people should grant, would make a total outlay of $250,000 for this purpose.

The Grand Rapids (Mich.) Board of Public Works has issued an order forbidding the waterworks to use Cold Brook as a source of water supply, owing to the foulness of the stream. This proves a great inconvenience, as water will be very scarce during the balance of the summer months.

According to the Rockford (Ills.) *Weekly Register*, 563,423 gallons of water are pumped in that city every 24 hours, being 43 gallons to every man, woman and child in the city, provided they all used Holly water. There are 460 actual water takers, which would give 1,236 gallons to each taker.

The question of a larger and more efficient water supply is being discussed by the citizens of Sterling, Ill. P. B. Perkins, Hydraulic Engineer, of Dixon, Ill., in a recent communication upon the subject, to the City Council, offers to increase the supply to that considered necessary, for the sum of $2,885.

The Oakland (Cal.) *Weekly Transcript* of the 13th says: "The Supreme Court has rendered a decision in the controversy between the city and Spring Valley Water Works. It is in effect that water for the public institutions should be paid for, but furnished for sprinkling and sanitary purposes free of charge."

The Burlington, Iowa, Water Company, have accepted the franchise granted them by the City Council and with T. N. Boutelle as engineer will proceed immediately to the construction of waterworks to cost not over $200,000 and embracing pumping machinery of three million gallons capacity, daily, and about fourteen miles of pipe.

The London, Ont., City Council, at a special meeting on the 16th inst., approved of a scheme for the construction of water works, to cost $150,000. The voting on the by-law will take place on the 22nd of August. The area proposed to be served with pipes is bounded on the north by Grosvenor street, on the west by Ridout street, on the south by South street, and on the east by Adelaide street.

At a special election at Johnstown, N. Y., on the 19th inst., the project to expend $60,000 to build water works was defeated by twenty-seven votes. The election was of a most exciting character, but it appears that the waterworks projectors did not go at the people with just the best proposition. However, the projectors claim that inasmuch as they were defeated by so small a vote they will succeed in a future contest.

The committee on water works, of which Mayor Edwards is chairman, for La Crosse, Wis., in accordance with authority given them by the City Council, as noticed in our last week's issue, have advertised for proposals until Aug., 1st, for furnishing and laying about 10,000 feet of six, eight, and ten inch cast iron pipe, together with the necessary four inch pipes, hydrants, valves, etc. The work is to be commenced on or before August 15th, and to be finished before the 15th day of September. (We omit to print the above proposals in full on account of the short time allowed.—*Ed*).

Work upon the new water works at Newport, R, I., which are being built as a private enterprise, by a Mr. Norman, is proceeding vigorously, The engine house, which will be a building of fine architectural proportions, is to be built at once; it will be a brick structure, with a slate roof, the interior to be divided into two rooms, one 28x39 feet for an engine room, and the other 28x29 feet for boiler room. A large force is at work upon the embankment, and the dredging machine will be set at work at once. The main pipes from the pond to connect with those previously put down are being laid, and the whole business of introducing water is being driven with all possible dlspatch.

Eau Claire, Wis., is to have gas works. The capital stock of the company constructing the same is $100,000, the officers being John Everitt, of Boston, President; A. E. Swift, Chicago, Vice President; and Geo. S. Redfield, Chicago, Secretary. The dimensions of the fire proof buildings, work upon which will be commenced at once, the contract having been let, are 100x32, 90x32 and 60x60, and a cistern 55 feet in diameter and 17 feet deep. The pipe has been ordered and will commence to arrive within the next two weeks, when work upon the mains will begin. About five miles in all will be laid and it is the intention of the company to have the new works completed by November 1st.

From the Dayton, O., *Journal*, we learn that the waterworks at Woodland Cemetery are nearly completed. The well is finished, a pump house erected over it, the pump put in, the supply pipe laid, the reservoir dug, and over six hundred feet of mains laid to different parts of the grounds. The pump house is a brick structure 16x20, surmounted with a slate roof, Gothic style, and contains the boiler and an automatic pump. To run the latter requires seventy pounds of steam. The water is forced 650 feet through a six inch supply pipe, which is laid with a slope up to the reservoir. The vertical height the water is forced is 185 feet. At the pump, the pressure on the inside of the supply pipe is 90 lbs. to the square inch. The reservoir is 70 by 30 ft. and three feet deep The bottom and sides are of puddled clay to make it water tight, and covered with a layer of clean gravel. The brink of the basin is sodded all round. Workmen are busy laying mains along the principal avenues, and shortly hydrants will be erected at convenient points, and the whole apparatus be ready for use.

At a meeting of the City Council of Keokuk, Iowa, July 18th, an ordinance amending the water works ordinance, was passed, of which the Keokuk *Gate City* says: "It is understood that the Company will accept the ordinance as amended, and if the $25,000 stock can be raised here the water works may be considered a fixed fact." The ordinance referred to provides that the Keokuk Water Company shall accept in writing the terms and conditions of the Ordinance within sixty days from July 18th, and that within one year from the date of the franchise the said Company shall have its water works, comprising two engines with separate boilers and pumping apparatus attached to each, each of said boilers to have separate engines attached for the purpose of supplying said boilers with water, and each having a pumping capacity when the piston is traveling not over one hundred and fifty feet per minute to furnish seven hundred and fifty thousand gallons of water each and every day—ten miles of mains, seventy-five double hydrants, and the requisite stop valves and other appendages in full operation, and also stipulates that the water to supply the city shall be taken from the main channel of the Mississippi River, outside the line of the Des Moines Rapids Canal, and above the lower line of High street and that same shall be filtered through the most approved machinery used for

that purpose. Later correspondence informs us that the whole matter is, as yet, in abeyance.

The West Troy, N. Y. water works, which have just been completed, are a model in their way and fully sufficient to give West Troy an abundant supply of sweet and pure water. The pumping house is located on the, bank of the Mohawk, about four miles back of West Troy, and is situated in a recess cut in the solid rock the building standing four feet below the level of the river. The structure is very strongly built and is supplied with a Flanders pump, operated by a submerged turbine wheel of great power and capable of pumping into the reservoir, nearly four miles distant, 2 000,000 gallons daily. The reservoir which lies half a mile back of West Troy, is simply an immense gorge or ravine, closed so as to form a lake forty feet deep, covering a surface of fourteen acres, and containing about 70,000,000 gallons of water. The summit chamber, the highest point on the line of the works, is 160 feet above the level of the Mohawk, and the dam across the Mohawk is 50 feet in height, 250 feet wide at the base, sloping to 30 feet at top, and 600 feet in length. The works supply eighty-five hydrants in West Troy, and cost in the aggregate about $200,000. The officers of the company are: G. A. Meneely, President; Alfred Mosher, Vice President, and George M. Wiswall, Secretary and Treasurer. Negotiations between the company and the village authorities of Green Island are pending, and it is expected to commence an extension to that village in a short time.

CONTRACTORS.

Kokomo, Ind., is to have a new city building, station-house, etc.

The piers of the Fullerton avenue conduit, Chicago, in the lake, have been completed.

Fort Wayne, Ind., talks of building a tunnel under the Pittsburgh railroad tracks at a cost of $70,000.

Bricks perforated with three holes, that the mortar may get a good "hold," are being used in the construction of some buildings in Minneapolis, Minn.

The commissioners of Madison county Ind., have accepted the plans of Elwin May, Architect of Indianapolis, for a county asylum to be built near Anderson.

Masons from Boston and elsewhere have been arriving at St. John, N. B., in large numbers, but leaving again, as there is no work and poor accommodations.

The Commissioners for the new court house at Chattanooga, Tenn., had a meeting Monday, the 16th inst. and determined to advertise for plans for the construction of the building.

The two cribs just successfully sunk in the harbor at Michigan City, Ind., contain 253 cords of stone. An appropriation of $100,000 has been recommended for this harbor for the coming year.

The citizens of Washington Heights, Ill., have voted to issue $9,000 worth of bonds for the purpose of purchasing a lot and building thereon a school house, to be completed in season for the Fall term.

The contract for something over 300,000 choice brick, to be used in the construction of the Memphis custom-house, has been awarded, at $13 per thousand, to Chas. Jones, of that city. The value of the brick will exceed $10,000.

The contract for building the Union Pacific depot across the river at Omaha, which is expected to cost $100,000, was closed on the 18th inst., and work will be commenced at once. It is intended to have the building under roof before winter.

The contract for the erection of the State Reform School Building at Pontiac, Ill., was let on the 20th inst., to Thomas & Hugh Colwell, of Ottawa, for $783 less than the architect's estimate. The building has been located and work will commence at once.

The Michigan State Board of Education has recently been in session in Ypsilanti, the principal object of the meeting being to adopt a plan for the building of the State Normal School, for which purpose $30,000 was appropriated last spring by the Legislature.

The Board of Public Works of Milwaukee, have advertised for Architect's Plans, which were to have been considered on the 25th inst., for a new public school building in that city, which is to be of solid brick walls to contain six class rooms of a capacity of about 27x33x13, high with necessary cloak rooms and closets and water closets, and to cost about $8000.

Bids for the construction of a tunnel and roadway under the Miami & Erie Canal on Mitchell Avenue, were opened at the office of the Commissioners of Hamilton County, Ohio, in Cincinnati, on the 18th inst., as follows; Hugh Campbell, Cincinnati, $60.560.; John Humphreys, Cincinnati, $59.800.: M. Bogenshot & Son, Harrison, Ohio, $55.495,91; Madison Peter, Cincinnati, $46.000. The contract was awarded to Madison Peter at his bid.

MISCELLANEOUS.

A number of manufactories in Pittsburgh which have been closed are being put to work again.

License has been issued to the Champaign, Ill., Street Railway Company; capital, $10,000.

The Pittsburgh *Gazette* declares that the progress toward better times is apparent. In the iron trade the volume of business has been equal to the average for the last seven years.

Charlottetown, P. E. I., has appointed a city engineer, at a salary of $500 per annum; and has resolved to purchase a new steam fire engine.

Patent car wheels, having steel tires and rubber packing between the tire and center, are being manufactured at Nashua, N. H.

About 700,000 tons of Bessemer steel were made in England last year, and about 525,000 tons were made in the United States in the same period.

The last artesian well at Lansing, Mich., (the third in number, but only the second successful one) is completed, the depth being 676 feet.

Lieut. E. M. Weaver of the 2nd Artillery, U. S. A., has been detailed as Professor of Military Science and Engineering at Western Reserve College, Ohio.

The Pennsylvania Steel Works of Harrisburgh have orders enough to keep their works running day and night until November. They now employ 1200 hands.

The necessary pipes to be used in Mr. Holly's project for heating Lockport, N. Y., by steam, are nearly all down, and the system will be given a trial in a few days.

The amount of lumber surveyed in the State of Maine from January 1 to July 1 was 45,949,760 feet—an increase of 1,192,900 over the corresponding period of last year.

The Missouri River at Council Bluffs, on the 9th inst., formed a new bed on the east side of the stream, cutting off 500 acres of land and shortening the channel five or six miles.

The citizens of Dubuque, Iowa, are quite enthusiastic over their street railway on the bluffs. The new motor works to the satisfaction of all concerned, and draws the cars with as little fuss as the horses do on the level streets.

The first and only synagogue, west of the Mississippi River and north of St. Louis, was consecrated at Keokuk, Iowa, on the 20th inst. The cost of the edifice, is about $16,000, Alex. Black, Esq., of Keokuk being the architect.

Col. D. C. Jenne, engineer in charge of the Illinois river improvements at Copperas Creek and Henry, says the work on the dam at Copperas Creek has recently been very much retarded by high water and heavy rains and has been entirely suspended at times.

Gen. Beauregard, in a published letter of considerable length, under date of July 13th, gives quite an exhaustive account of the progress thus far made upon the Jettics at the South Pass of the Mississippi River, and predicts that they will be entirely successful.

The people of Lambertville, N. J., wanted a supply of water for Mount Hope Cemetery, and engaged an expert with a divining-rod to diagnose the ground and locate a well. He did so, and at 38¼ feet depth the scientists concluded to let well alone, and consult an engineer, even if he didn't employ a forked stick.

The question of more thorough drainage is occupying the attention of the citizens of Rockford, Ills. A fresh interest is attached to the matter just at present on account of the extensive prevalence of scarlet fever. So general has this disease been throughout the city that Sunday schools have temporarily suspended.

A new lighthouse to take the place of the beacon lighthouse in Oswego, N. Y., harbor has arrived there. It is entirely of iron, weighs twenty-five tons, and was manufactured at the West Point Cold Spring Foundry. It has a thirteen feet base, twenty-six high, focal plane, and can easily be removed at the pleasure of the department.

The Boston, Common Council, at a recent meeting passed an order to make the East Boston ferry free after January, 1878, and also to purchase one hundred acres of land on the Back Bay for park and sanitary purposes. An order authorizing the borrowing of $3,713,000 for improved sewerage, after being read once, was laid over one week.

In the construction of refrigerator cars, it has been found by experience that chill-rooms for the preservation of perishable articles have the standing objection that at or near the temperature of freezing, meat and other like articles may be kept a long time without going to decay, but when brought thence into a summer temperature they go almost immediately to destruction. Forty-five degrees or thereabouts, with moderate ventilation, will in a good measure decrease the objection to the use of chill-rooms.

Among recent improvements introduced by City Engineer Scowden, of Louisville, Ky., is a new circular catch-basin with pipe-traps connecting the street gutters with the sewers. Practical men commend it because its circular form adds so materially to its strength that repairs will scarcely ever be needed, an expense to the city which heretofore has been quite heavy. Another feature of the improvement is, that the inlets to the new basin are placed directly in the gutters at the footway crossings, covered over by a cast-iron plate which conceals the catch-basin openings from view, and prevents the possibility of an accident to pedestrians.

A rather peculiar piece of engineering work has been completed by the Chesapeake and Ohio company to make a new outlet from the canal to the Potomac. The elevation to be overcome was 40 feet, which under the old system, would require 8 locks and nearly an hour's time for the passage. The new arrangement is the employment of a large caisson or tank filled with water, into which the boat is floated, when the caisson, with its load of water and boat, is run down the incline on rails in less than six minutes. The weight of the loaded caisson is about 350 tons. The first expense of constructing locks and the constant expense of operating them in repairs, is saved, as well as the time.

Nearly 400 men are now at work on the various shoals at the head waters of the Cumberland River, for the improvement of which Congress at its last session appropriated $52,000. Heretofore the navigation of the Upper Cumberland, has been attended with a considerable degree of danger, the average loss of coal boats making the descent of the river, being one out of every five. The shoals are being so improved by dredging and the building of dams that the volume of water will be very considerably increased, while enough will be accomplished at the falls this season to enable twice as many boats to be sent over them as formerly. The country at the head of navigation is extremely rugged in character, and the river runs through a deep gorge with perpendicular sides. The Cincinnati Southern railroad bridge is approached through a tunnel on one side, while the bridge rests upon a great bluff on the other. Capt. N. C. Overman, U. S. A., the engineer in change, pronounces the river to be capable of being very greatly improved, and as it is now the only means of transporting the products of that region, it is of the utmost importance that the improvements should be made as substantial and on as efficient a scale as possible.

The first strand of the new suspension bridge between New York and Brooklyn was lowered on the 12th. The approaches to the bridge are to be of granite, made up of a series of arches, with stone crossings at Cliff and Vandewater streets, New York. At all other streets there are to be iron bridges of boiler plate. The architecture is to be Florentine style, and will cost $2,141,318. This will include an engine-house, which is to operate the cars with an endless chain. The arches under all the bridges are to be utilized for warehouses, and are to be built of granite, with inside walls of brick. An Exchange further says: "There is some prospect that work on the East river suspension bridge, between New York and Brooklyn, will be stopped until a case in the United States Circuit Court, involving the right of the two cities named to build the structure, is referred to the Supreme Court for final decision. The question raised is whether these cities have a right to build a bridge which will be an obstruction to navigation. The Secretary of War has never approved the plan of the bridge, as required by law, and the complainants claim that it obstructs navigation. The strands of the bridge are now in position, and are 145 feet above high water. This will allow the passage of small craft, but high-masted ships, it is said, cannot pass under it. The work has already cost seven and a half millions of dollars."

SCIENTIFIC.

A recent trial of the new kaolin light has proved it to be steady and brilliant, and capable of being used to advantage on board of vessels, notwithstanding the agitation which may be produced by the waves.

An Italian opitician, residing in Paris, has invented a new thermometer. A sheet of platinized silver is the heat measurer, and its movements are amplified by a series of levers until they are large enough to be represented clearly on the dial.

By a series of experiments conducted with the electric sparks, it has been discovered that drops of various liquids—water, milk and quicksilver—let fall upon a horizontal plate do not make, as has been supposed, an indiscriminate splash, but pass through changes of singular symmetry and beauty.

The Russian Government has decided to introduce the new electric light into fortresses. Recent experiments show that, in clear weather, these lights render light targets distinctly visible at 1,500 meters—very nearly one mile; at 1,000 yards a sunken battery was plainly visible, with men working therein; and at 750 meters the tools of the workmen could be distinctly made out.

There are irregular tides in the great lakes. On the 10th instant there was a sudden fall of one foot in the level of Lake Ontario, the cause of which is unknown. These tides occur at all hours of the day, and have been known to occasion accidents to boats in shallow water, the sudden receding of the water leaving the boat on rocks where a few moments before there had been an abundance of water.

An improvement on dynamite is said to have been effected by M. Fahnehjelm, of Stockholm. For the infusorial earth used in making dynamite, he employs a kind of wood charcoal, which not only absorbs the nitro-glycerine, but serves as an important factor in the explosion of the composition. In order to give a speedier action to the new explosive, which is called "sebastin," nitrate of potassa is added. The nitro-glycerine, charcoal and nitrate of potassa are combined in various proportions to suit the purposes for which the sebastin may be intended.

ARCHES;
CONSIDERED GRAPHICALLY.

(*Continued from page 193.*)

80. The bending moment M at any point has been demonstrated, § 7, to be equal to the product of H from the stress diagram multiplied by the ordinate for that point of the funicular polygon or moment curve. Then it was shown, § 23, that, if all these ordinates were summed up, that is, if we took Σ E F between two points, the same would be *proportional* to the change of inclination between those two points; but it was not stated that this quantity was *equal* to the change of inclination, for neither the material nor the form of cross-section of the rib was taken into account. As the amount of flexure has just been stated to vary inversely as E and I, we must write $\frac{\Sigma M}{E I}$ or $\frac{H . \Sigma E F}{E I}$ to obtain a quantity which shall equal the change of inclination. The same thing is true of the expressions for deflection and for change of span. When, however, the summation is made from one abutment to the other, and then put equal to zero, if E and I are constant, as well as H, it must be true that Σ E F = 0, as heretofore stated; and so of the other equations. Now E is constant, as the material of the rib is the same throughout; and since the parabolic rib, of cross-section varying with the secant of the inclination of the rib to the horizon, has been demonstrated, § 41, to deflect vertically like a straight beam of uniform section equal to that of the rib at the crown, I is likewise constant in these formulæ, and represents the moment of inertia of the section at the crown. In short, when one quantity is proportional to another, if one is equal to zero, the other is also; consequently we can deal with areas, area moments, etc., as if they were the changes of inclination, deflection, etc., themselves.

81. But now we wish to introduce the distance $2\,t\,e\,c$, the change of span which would occur from temperature were it unchecked; as this is an absolute and not a proportional quantity, we must divide our original quantity for change of span, § 10, by E I. We shall therefore have for the new condition, as explained before,

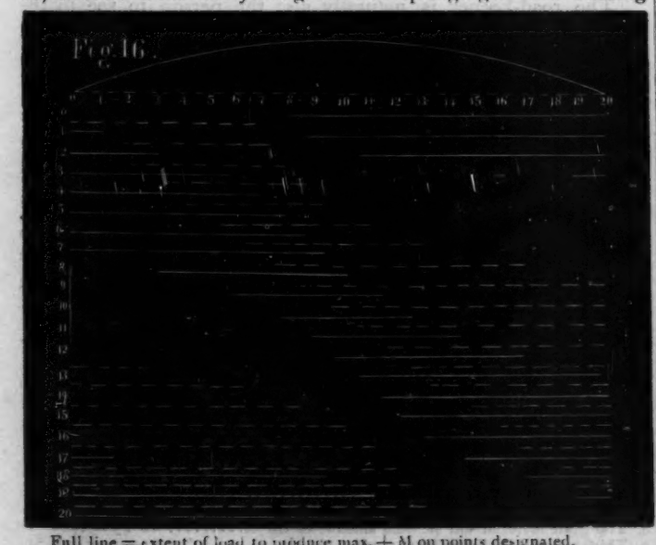
$$\frac{H_t . \Sigma E F . D E}{E I} \pm 2\,t\,e\,c = 0,$$

where H_t is used to signify the horizontal force (thrust or tension) which is occasioned by the change of temperature; or, if we clear of fractions, we get the more convenient expression

$$H_t . \Sigma E F . D E \pm 2 E I\,t\,e\,c = 0. \qquad (22.)$$

A rise of temperature will make H a thrust or positive, while a fall of temperature will make H a tension or negative. The double sign is not needed in the above equation if the sign is contained in the symbol t, that is, if t is negative for a fall of temperature below the one at which the rib is constructed or laid out. The bending moments exerted on the rib will be of the contrary kind when H_t is minus, while the ordinates are of course unchanged.

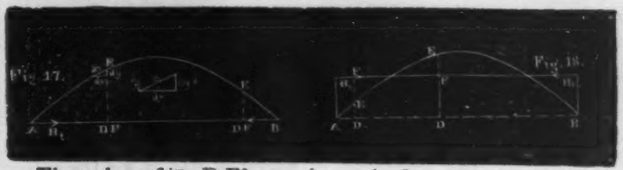
82. To take up first the case of the parabolic rib hinged at ends. The amount of H_t is to be determined. As there can be no bending moment at either abutment, and H_t at each abutment is the only applied force, the curve of equlibrium or line of thrust, Fig. 16, must be in the line joining the two springings. The bending



Full line = extent of load to produce max. + M on points designated.
Broken line = equals extent of load to produce max. + F between points designated.
Blank space for max. − M. do. for max. − F.

moment at any point will therefore be equal to the ordinate to the rib at that point multiplied by the desired value of H_t. The expression Σ E F . D E therefore becomes for this case Σ D E², and we have, transposing the second term of equation (22.),

$$H_t . \Sigma D E^2 = 2 E I\,t\,e\,c.$$



The value of Σ . D E² was shown in § 45, (10), to be $1\frac{1}{8}\,k^3 c$; therefore, substituting and transposing,

$$H_t = 1\tfrac{1}{8} . \frac{t\,\xi\,E I}{k^2}. \qquad (23.)$$

a value which is independent of the span.

The maximum bending moment, which occurs at the middle of the span, where the ordinate will be k, is,

$$M\ (max.) = \tfrac{9}{8}\,\frac{t\,\xi\,E I}{k}.$$

The ordinates at all the usual points of division will be the values of z, used repeatedly before, and, by multiplying H_t by these several values of z, the bending moments at all the points are obtained for a given change of temperature t. An additional line can be placed below the table of M to contain these quantities, so as to have them convenient for use. All of these moments will be positive for a fall of temperature below, and negative for a rise above that at which the rib was designed. The worst effect of either change must be provided for.

83. If one likes to prove this value for change of span analytically, he may proceed as follows: Let any ordinate to the arch be denoted by y and the abscissa measured horizontally from one abutment by x. Then, if v = the vertical deflection ordinate, we may write the usual equations for curvature, slope and deflection of beams, recollecting that this arch acts like a beam of uniform section in deflecting vertically,

$$\frac{d^2 v}{d x^2} = \frac{M}{E I}; \frac{d v}{d x} = \int \frac{M}{E I} d x; \text{ and } v = \int\int \frac{M}{E I} d x^2.$$

Now $M = H_y = H\,\frac{k}{c^2}\,(2\,c\,x - x^2)$; therefore

$$d v = \frac{H}{E I} . \frac{k}{c^2} \int (2\,c\,x - x^2) = \frac{H}{E I} . \frac{k}{c^2}\,(c\,x^2 - \frac{x^3}{3} + c)$$

$\frac{d v}{d x} = 0$, for $x = c$; therefore $C = -\frac{2}{3}\,c^3$. Then

$$\frac{d v}{d x} = \frac{H}{E I} . \frac{k}{c^2}\,(c\,x^2 - \frac{x^3}{3} - \tfrac{2}{3}\,c^3). \qquad (a.)$$

If u = change of span, the infinitesimal displacement $d u$ due to the portion of arc $d s$ will give, as may be seen in Fig. 17, $d u : d v = d y : d x$. Since $y = \frac{k}{c^2}\,(2\,c\,x - x^2)$; $d y = \frac{k}{c^2}\,(2\,c - 2\,x)\,d x$, and we have $d u = \frac{2\,k}{c^2}\,(c - x)\,d v$.

Substitute the value of $d v$ from (*a.*) and it becomes

$$d u = \frac{H}{E I} . \frac{2\,k^2}{c^4}\,(c^3 x^2 - \tfrac{1}{3}\,c\,x^3 - \tfrac{2}{3}\,c^4 + \tfrac{1}{3}\,x^4 + \tfrac{2}{3}\,c^3 x)\,d x.$$

If this equation is integrated between the limits 0 and $2c$, we obtain $u = -\frac{H}{E I} . 1\frac{1}{3}\,k^2\,c.$, which will be seen to correspond with the value of $2\,t\,e\,c$ in § 87.

84. If we turn next to the rib with fixed ends, it will be manifest that, since there will be bending moments at the springings, the line which corresponds to the curve of equilibrium and limits the ordinates for bending moments cannot now pass through those points. As the resistance to expansion or contraction is the only cause of these moments, the two abutment moments will be equal and the line will be horizontal. In order also to satisfy the condition that the total change of inclination shall be zero, or, as expressed in § 65, (6), Σ E F = 0, the horizontal line must be so drawn as to make the areas within and without the arch equal to one another, which will occur when the line is drawn at a height of $\frac{2}{3}\,k$ above the springing, as seen in Fig. 18. To prove the equality of areas it is only necessary to recall the fact that the area of a parabolic segment equals two-thirds of the enclosing rectangle. The area included within the whole arch will therefore be $\frac{2}{3}\,k . 2\,c = \frac{4}{3}\,k\,c$. The rectangle of height $\frac{2}{3}\,k$ has the same area. Therefore the portions of the arch area and of the rectangle which do not coincide must be equal to one another. The third condition of § 65, that Σ E F . D B = 0, or the equality of area moments, is also satisfied by this construction; for the rectangle multiplied by the half span, which is the distance of its centre of gravity from one abutment, is equal to the area included by the whole arch multiplied by the same distance.

The bending moments for temperature, in both the arch with hinged ends and that with fixed ends, will therefore vary like those of a beam uniformly loaded and either simply supported or fixed at the ends.

(*To be continued.*)

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,
Civil Engineer, Member of the American Society of Civil Engineers.

(Continued from page 194.)

A French engineer, named Tresaguet, was the first, in 1875, to call attention to this proper method of making road repairs. His system — the above described one — was adopted in Baden in the year 1845, and has been long in universal use in all the active European countries. The two tables below give, the first, the actual average quantity of road macadam used per mile of road in Baden to make the repairs in one year, and show the decrease after 1845. The second gives, in the first column, the cost of materials and labor required to repair one league for one year according to the old way, — this column being calculated for the years following 1845 from the cost of the preceding years, and allowing for the increased value of labor and materials, — while in the second column we have the actual cost, as it was with the system followed at the time:

TABLE I.

YEAR.	Cubic yards used per mile in one year to repair roads.
1832.	218.6
1839.	193.7
1851.	127.2
1855.	91.4
1856.	89.4
1860.	93.4

TABLE II.

YEAR.	COST OF REPAIRS OF ONE LEAGUE OF ROAD.	
	By old way of so doing, in florins.	By system of continual repairs, in florins.
1835.	1,002	1,002
1840.	1,086	1,086
1845.	1,170	$975\frac{36}{60}$
1850.	1,254	$965\frac{40}{60}$
1855.	1,339	$835\frac{56}{60}$
1860.	1,423	$978\frac{54}{60}$

These figures are taken as given by the chief enginneer of the Baden Public Works, Mr. Keller. He quaintly adds: "These tables give clear evidence in favor of the reduced *cost* by the adopted system. That roads are *better* now than they formerly were, everybody knows." Another German engineer expresses himself to the same effect in a little different way. "It costs more," says, he, "to keep the roads in repairs now (1864), than it did twenty years ago, when this method (of continual repairs) was not in use, although labor is now three times and materials are twice as dear as they then were." There seems to be no doubt of the superiority of the continual repair system in every respect, producing very much better roads, and at the same time costing less. It need only be tried with us to be thenceforth adopted.

HOW TO REPAIR ROADS ON THE CONTINUOUS SYSTEM.

We suppose the material for the road covering to lie in regular measured heaps, all ready to be used, at the storage places, once or twice above mentioned, as being 200 to 250 feet apart alongside of the road, but not encroaching upon it. Then for every two or three miles of road, a so-called road-keeper is employed to do the necessary work and repairs. An enumeration of his duties will comprise at the same time an essay on the art of road repairing.

1. The road-keeper is to remove the dust formed in dry weather by sweeping with a brush broom. This is done to greatest advantage just after a slight shower. In muddy weather it is essential that the mud be removed by means of brooms or hoes. A little mud on the surface causes ruts, and much mud softens up the whole road surface. The mud is to be raked up in heaps alongside of the road, there left to dry and then carted off. To hinder as much as possible the formation of any mud, the surface drainage must remain unimpaired; should it be out of order, the water standing on the road is to be swept off. To diminish the wear of the road in dry times, the road should be sprinkled.*

2. Inasmuch as the covering gradually wears off, notwithstanding all precautions, it must be renewed, and should be so renewed gradually, in the same measure as it wears off. The best time to put on new road metalling is during continuous wet weather.

3. In filling up holes, the bottom of the same is to be swept clean of mud, then filled up level with the remainder of the road, not in a heap so high above it as to obstruct travel.

Every care should be taken to have the new material join as speedily as possible with the old portion of the road, and it should be so well laid that it will give the least possible hindrance to vehicles, which will then not avoid the patched places.

4. When many ruts occur in a short distance, the deepest only are to be filled at first. After the patching in these has become solid, then the rest are to be attended to. Long ruts or wheel tracks are not to be filled up the whole length at once, but only short pieces at a time. If this precaution is neglected, vehicles avoid such places, and new ruts are formed elsewhere.

5. Inasmuch as more material is worn off in a dry season than can be put on, there are then, when wet weather comes, large places to be repaired. These must be mended by degrees, never filling up a piece larger than 8–10 x 4–7 feet at a time, and not having these pieces too near together; when these have become solid, then some more may be fitted in and so on till the whole is done.

Should it however become absolutely necessary to repair a piece of road in dry weather, the place where the new macadam is to be deposited must be loosened up with a pick, then the new material put on and a solid top formed by the judicious use of stone dust or other binding material and sprinkling with water and pounding down with the shovel, or by what may be called "puddling" until the whole be solid. Should a frost or very dry weather occur immediately after macadam has been put on the road in wet weather so that the same will not join on the rest of the road surface, the whole must be removed, cleaned and returned to the storage heaps for future use. A layer of macadam over the whole road should never be put on without treating it immediately afterwards in the manner described above for building new roads, that is, mixing in binding material with the top course and rolling it in wet weather, or after sprinkling.

The road-keeper is naturally also the person to see to the proper delivery on the part of the contractors, if such there be, of the road material in the prescribed places, and to attend to the measuring of the same.

In short and to sum up, it is his business to keep the road in good order, and with proper men and surveillance the desired result is achieved easily and at a less cost, than by any other system. The quantity of macadam required to keep a certain length of road in repair varies very much; it depends, as we have seen, on the care with which the repairs are made, naturally also on the kind of stone used and on the amount of travel over road. For a width of road = twenty feet, the average quantities required per year to keep a length of ten feet in repair, on the system of continuous repairs, has been given as follows:

	Cubic feet.	Cubic yards
1. Good material and heavy travel	15–20	= .55–.74
2. Good material and medium amount of travel	10–15	= .37–.55
3. Good material and light travel	5–10	= .18–.37
4. Medium material and heavy travel	20–25	= .74–.92
5. Medium material and medium amount of travel	15–20	= .55–.74
6. Medium material and light travel	10–15	= .37–.55
7. Third rate material and heavy travel	25–30	= .92–1.01
8. Third rate material and medium amount of travel	20–25	= .74–.92
9. Third rate material and light travel	15–20	= .55–.74

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

* Bowles, in his book, "Our New West," mentions the case of the stage road from Sacramento to Virginia City, *via* Placerville, one hundred and fifty miles long, and having an annual traffic of seven or eight thousand heavy teams, and whose proprietors found that the simplest and cheapest way of keeping it in repair during dry weather was to sprinkle the whole of it, — one hundred and fifty miles of mountain road.

(To be continued.)

OBJECTS OF INTEREST IN PITTSBURGH.

II.

There are a great many bridges in and around Pittsburgh, both road and railway structures, of a decided variety of types, and one can spend a day or two to advantage in noticing their peculiarities. We did not take any measurements with a view to a specific description of them, during our recent visit to Pittsburgh, but we presume that many of our subscribers would be interested in such details of those which possess novelty as some of our readers in that city might be able to furnish.

We spoke of the Point Bridge in our last issue. Across the Monongahela River is a suspension bridge of several very moderate spans, built by Roberts, and evidently constructed many years ago, in the comparatively early days of suspension bridges and wire rope. On the other side of the city, crossing the Allegheny River, is a more modern suspension bridge by Roebling of two main spans and two half spans at the ends. The towers are of wrought iron, and the bridge is stiffened by a straight truss so as to be very quiet under the traffic. Inclined suspending ropes, running from the tops of the towers to numerous points between the piers and the quarter span, are intended, as usual, to assist the main cable.

The second bridge above this one, on the same river, is a wrought iron, rivetted lattice of five spans, with shorter spans of heavy plate girder at each end. It is a double track bridge with three trusses, and on one span the trusses diverge so as to accommodate a switch and three tracks at the shore end. It belongs to the Pittsburgh, Fort Wayne & Chicago R. R. This structure does not strike one very favorably, as the parts, both chords and lattice bars, appear to be of the same sections at all points of the span, not an economical disposition of material.

A little distance above on the same river may be seen one of the old fashioned Burr Truss, highway bridges of four spans, built entirely of wood, even to the tension members, each truss being assisted by a wooden arch. There are also, as we have said, several other bridges, of wood and of iron, which possess no noticeable features.

Upon Forbes Street, however, may be found, at a distance of perhaps three miles from the centre of the city, a very pleasing and airy looking structure, which carries in a single span this street over a deep ravine. It is a light circular arch, of concentric ribs with rivetted diagonal bracing, and was designed by Mr. Pfeiffer, who, after his experience with the St. Louis Bridge, undoubtedly turned off this structure, which resembles it in miniature as to type, very easily. It was, if our recollection serves us, illustrated and described in *Engineering* soon after its erection, and this description was copied by the *Scientific American*. As we are penning these few remarks away from our office, we have not access to our files and cannot speak more definitely.

About a mile from this bridge, across the same ravine, where it widens out on nearing the Monongahela, has been erected the Sylvan Avenue Viaduct, which consists of several light, iron, skeleton piers of considerable height suitably braced at intervals, connected at the top by trusses which resemble an inverted bowstring girder, the panel lengths of the tension member being straight. As the truss has considerable depth for its span, the bottom chord has therefore a very decided angularity, if we may so call it, and the effect, as viewed from below, is far from agreeable.

The works of the Keystone Bridge Company are well worth visiting. This company have just completed the large truss for the Cincinnati Southern Railway, now in process of erection over the Ohio, and are not very busy at present in their usual line of work, but are engaged in building some engines for an extension of the Lucy Furnace, close by. They have excellent facilities, however, for prosecuting bridge construction, possessing large and well arranged shops, assembling-house, and draughting-rooms. We inspected with much interest several special machines, many of them of their own design, which they have added to the usual plant of such works. Among these may be mentioned the rolls for finishing their patent rivetless column. This column, it will be remembered, is composed of segments with outside flanges, akin to the well-known Phœnix column, but fastened by a trough-shaped strip of iron placed over the flange and compressed by the rolls above mentioned so as to make a somewhat dovetailed joint, holding the segments firmly together.

The company have also after long experimenting, succeeded in constructing an Automatic Punch, which will punch the required holes in strips of plate, angle or other iron with whatever spacing is desired, and with great accuracy, as an attendant revolves a hand-wheel with accompanying index. Each complete revolution of this wheel moves the bar, or piece to be punched, one inch. At one side of the shop may also be seen the special machine for facing the ends of the St. Louis bridge arch sections, so as to secure the exact angle of obliquity of the end to the axis of the section, and the arrangement for making the coupling grooves. They have also a milling machine for bringing eye-bar heads to any desired shape, the cutters being guided by a template.

Their large testing machine, working by hydraulic pressure, will take in columns or bars, for compression or tension, up to thirty-five feet in length, and is capable of exerting a force of five hundred tons. We understand that quite extended experiments have been made upon various columns and forms of strut, and we hope that the results may soon be published. Their upsetting machine for heavy work, also acts by hydraulic pressure, but they have adapted a machine, orignally intended for mining coal by repeated blows, to the upsetting of light bars. It appeared like a rude contrivance, but certainly did its work rapidly and well. The rivetting machine has a movable post, balanced or kept up to its place by a weighted lever. In case a rivet is too long, or if, for some reason, there is unusual resistance, the post will yield, turning about its foot, in place of breaking. A patent clutch, also, is used on this machine, as well as on the punches, which ensures that the punch shall stop at the end of the back stroke,

At the Crescent Steel Works, which are near to the shops of the Keystone Bridge Company, may be seen the manufacture of crucible steel and its conversion into sheet, spring and bar steel, under the rolls or steam hammer. They use here the Siemens Regenerative Furnace, making the gas for all the works in one place, and sending forth from the top of the chimney stack but little more smoke than is seen issuing from the chimney of an ordinary dwelling. The iron pipe to the chimney was scarcely too hot for the hand, and here was afforded a beautiful example of the scientific and economical combustion of fuel. If all the iron furnaces with which both rivers are lined should introduce similar improvements, the change would make a decided difference in the quantity of inky smoke which is now wastefully vomited forth upon the city and surrounding country. The fuel is the very small bituminous coal or slack, formerly considered refuse, and with these furnaces it takes but sixteen bushels of slack to melt one ton of steel. One man can handle all the coal and ashes for large works. It is at these shops that they grade their ingots by ocular inspection. The accuracy of this method of determining the per cent. of carbon, by the appearance of a fresh fracture of an end or corner of an ingot has been demonstrated by repeated chemical analyses, and other physical tests have proved that the desired mechanical qualities of the ingot depend upon the amount of carbon. A difference of five one-hundredths of one per cent of carbon can be detected by the eye, and the expert marks upon the ingots their different grades as fast as he can handle the chalk. We saw the ingots marked and could see for ourselves distinctive differences in the lustre of the fractured surfaces. Some five or six grades were picked out by the marker by a glance of the eye. There is, therefore, needed only this discrimination as to quality to enable the manufacturer to supply the engineer with the grade of steel which he desires and definitely specifies.

A proof of these statements will be found in the article contributed to our columns by Prof. Langley and published in the current volume recently.

We send out with this number the Index and Title-Page to "Sanitary Engineering," thus completing the entire supplement. It has been delayed several months beyond our calculations, but it was difficult to push the work any faster under existing circumstances. We are now overhauling the plates, and will at once print and bind an edition for sale in the bookstores, which, we trust, will be ready in two weeks from date. The book will be bound in neat and substantial covers, and the price of the bound copies will be *Three Dollars*, post paid, to any address, but subscribers to ENGINEERING NEWS will be furnished the current volume of the paper and a bound copy of "Sanitary Engineering" for *Five Dollars*. Subscribers who may wish to have their sheets of "Sanitary Engineering" bound, can have it done by us, and returned, postage paid, for *one dollar*, the binding being uniform in style with that of the published edition to be sold in the bookstores. In doing this we can replace mutilated or soiled sheets at *ten cents* per sheet, but we cannot furnish plates at less than the price of the whole book, or three dollars for a single plate, as the want of *one* destroys the value of the whole volume. This price is contingent on there being a considerable number of volumes to bind at once, as we wish to keep the price as low as possible, and can only do so by getting quantity rates. It will be necessary, therefore, to come in with the edition that is to be bound immediately.

The element of riot and anarchy that seemed at one time last week to have complete possession of our country, is now pretty effectually subsided, if not extinguished. The result might have been sooner accomplished if, in our large cities, the officials in power, led by the mayors, had not been so much concerned about their future political prospects as to let slip a most excellent opportunity of thinning the ranks of the class who are not ashamed to beg, will steal whenever a chance offers, but will never work under any conditions. The "great strike" among the railroad employees continues, however, and is very seriously damaging the interests not only of the strikers themselves and the railway companies, but of the whole community. We believe in every man doing the best he can for himself, and if he is not satisfied with the wages which he is being paid he has the right to "strike;" but we have no sympathy with the man who raises his hand or his voice to prevent others from working if they choose to accept the pay; and it seems a very strange circumstance to us that a discharged employe is allowed by the authorities, State and National, to direct matters with such a high hand as has been done by Robert Amond on the Pittsburgh, Ft. Wayne & Chicago R.R. These men should be driven off at all hazards by the proper authorities, and the business of the railroad allowed to be managed by the officers of the railroad; this done, the question of wages may be settled between the belligerents. Under existing circumstances there can be no yielding with part of the railway companies, as it would be a precedent too dangerous to be established. The present difficulty can have but one ending, and that the usual and inevitable one of victory on the side of the companies, and worse than defeat to the strikers, for it will undoubtedly deprive them of the sympathy of many railroad managers who, we think unwisely, have been giving what was considered low wages to a surplus of employees, instead of satisfactory wages to just the number needed to do their work. We may now expect a weeding out of railroad men, and the transportation business conducted more on a genuine commercial basis than it has been heretofore. If the stockholders of this class of property will but be induced to actually look after their property and not be frightened or cajoled away by their high-toned servants in the handsome railway offices, or by their henchmen on the street, until they know whether said servants know their business or not, and how the money is spent, the present serious difficulties will not have been entirely without compensation.

Two French astronomers, M. Andre, and M. Ingot, will visit California next year to observe the transit of Mercury. The transit occurs May 6, and will be visible all over the United States.

The narrowing the gauge of the European & North American R. R., which extends from Bangor, Maine, to St. John, N. B., to 4 ft. 8½ inches, will take place immediately, and the engines and rolling stock are now being altered. The Bangor & Piscataquis R. R., will also at once change from broad to standard guage, and thus the last of the broad gauge lines in New England will disappear.

LAND SURVEYING IN THE DOMINION.

BY P. B. S.

III.

Arnprior is a lively little town of perhaps 2,500 inhabitants, situated at the confluence of the Madawaska and Ottawa rivers, the latter of which at this point widens into the Lake du Chats, or "the Shaws," as it is usually called, and is about three miles wide, and extends forty miles up the river. Immediately below this point is the Du Chats Rapids, around which passengers and freight by the river route were transferred on a horse-railway from one steamer to another. A railway now connects the Ottawa River at this place with the St. Lawrence at Brockville, and also with Ottawa City. But in 1860, when I commenced my temporary residence there as a surveyor's apprentice, it could only be reached from the south by a lumbering old stage wagon, which, by dint of getting over the twenty-six miles from the railway terminus in eight hours, landed its passengers at 2 A. M. at the decidedly comfortable hostelry well-known throughout the Ottawa region as the "Lyons' House," The settlement was then but three or four years old, but owing to the enterprise of its landlord, Hugh McLachlan, Esq., who was the leading lumberman at that time in Canada, it had already made considerable progress. The region about it was most desolate and uncultivated, and the entire population were dependent for support on the lumber trade. There was no agriculture, the men in the winter season being engaged in the pineries getting out square timber or sawlogs, and in the other seasons taking the same to market. Being a new region, and in view of its past progress and its promising future, by reason of the coming railway, my "master"—a well educated skillful, and enterprising young surveyor, "saw millions in it" as a good location, and it was accordingly to the "Lyons' House" as headquarters I came one July night in the year before mentioned, to enter upon the arduous and very responsible, and highly intellectual labors which are supposed to belong to the position of First Assistant to a Canada Provincial Land Surveyor.

The duties *were* extremely arduous, and it required a constant intellectual effort to discharge them faithfully! The first week was spent in comparing notes of the past year, of college life on one side, and experiences as a surveyor's apprentice on the other; the little town was "done;" the acquaintance of the hotel people made; instruments examined, and the prospects for business canvassed. We also learned the home and habits of every particular spider, by whose labors the little trellised porch of the hotel was festooned, as, lying on our backs on the the benches we watched them through the long, genial days (between meals) and learned to watch ceaselessly, and wait patiently, for a victim. Then we practised in the use of the birch-bark canoe, in which, being an expert myself, I gave lessons to my master, until he could step into the frisky structure, stand up in it, or even sit on a cross-bar without measuring his length in the river after each trial. After that we paddled about the lake almost daily, and to the opposite shores where, with our hammers of most approved pattern, we refreshed our geological knowledge amid the great variety of rock structure there existing. But this style of surveying grew monotonous, and being invited one day by a friend to go and spend a few weeks on a small steamer of his plying on a route farther into the wilderness, I gladly accepted, but after a month's close acqnaintance with the freighting of lumbermen's supplies, camp equipage and employees, I was just as well pleased when the visit of the Prince of Wales to the Upper Ottawa tempted me back to headquarters in time to see that virtuous young man ferried over Lake Du Chats in a bark canoe of many and bright colors, and, after a lunch at McLachlan's, rushed out of the little back woods town amid a jam of the worst looking vehicles, and the biggest dust which I guarantee his Highness encountered in his entire American trip. I then took a vacation from *my* severe labors and went home to wait for winter and more active business. It was cheaper and more pleasant than staying at Arnprior, and I could calculate the area of a rectangle, or read the Surveyor's Act just as well as I could under the immediate supervision of an exacting master. But with November came an order from the most remote post-office in the Ottawa region west of the river, to report for immediate duty, and a couple of days after, at earliest dawn, with my pack hung to my shoulders by a "thumpline," I was leaving the then remote village of Renfrew for a fifty-mile solitary tramp up the newly established "Opeongo Road."

The Canadian government has always made active efforts to encourage emigration to the remote and sterile regions at the headwaters of the Madawaska, Petawawa and Ottawa rivers, and years ago, in pursuance of this policy, roads were cut at government expense, through the endless forests that, by their extent and inaccessibility, dismayed the most courageous foreigner. These forests were mostly of pine, and were held in large tracts by the lumbermen, who discouraged all ideas of occupation by actual settlers who thereby became not only possessed of the pine growing on their grant, but were the frequent cause of complaint on account of trespassing on timber "limits" not their own. Along these government roads the land was laid off in farms 25 chains frontage by 80 chains deep, making 200 acres, which, with a given supply of farming tools, seed, and other necessaries were given to each actual settler. By reason of other conditions further grants of adjoining lots were made, but the condition of it all was actual settlement by building a house and breaking up a stipulated quantity of land each year for a certain number of years. The country back of Kingston and Belleville has in the past twenty years been opened up in every direction by these roads and a considerable settlement effected. Judging from my personal acquaintance with it at the time of which I am writing, I could see nothing to tempt settlement, and I can hardly think that any but a class of settlers low down in the scale of civilization, and knowing nothing better than squalid poverty all their lives, will remain in these regions, where a very short summer allows them to glean but a scanty crop from the slowly increased acreage which, during the winter months they rescue from the gloomy, interminable forests that surround them. Such was the class that had taken the farms along the Opeongo Road, a narrow highway winding among the stumps of the great pines that had been fallen to let in the light, with occasional bits of grading, and bridging or "corduroy" to gain a crossing over an otherwise impassable place, and connecting the settlements at Renfrew with the heart of the pine lands at Opeongo Lake which lies almost directly north of Cobourg, Lake Ontario. My master had been making a survey of some "limits" and a traverse of Lake Kamaniskaik for a lumberman, and his being in the neighborhood induced many of the settlers to have their boundary lines run. The farms were chained off along both sides of the road, allowing a 66 feet strip between, and stakes had been planted every 25 chains. At every one hundred chains a line was run to the rear and "blazed;" this line was termed a "proving line" and governed the course of the lines west of it. To survey a line therefore, the "proving line" had to be run with the transit and a base line turned off therefrom and run to the post in the required boundary, thence a line run to the rear parallel to the proving line and 80 chains exactly.

At noon of the second day I laid down my pack in an Irish hovel, where I found my master regaling himself with the regulation pork, potatoes, bread and tea that formed the staple diet wherever we went, and which scarcely ever varied in degree of unpalatability and nauseousness. My life as a student now commenced in earnest. We passed nearly the whole winter in this villainous region and having made arrangements for stabling our horse, we would walk from survey to survey in the neighborhood until our services were sought for in some other locality. The use of an apprentice in such a region at once became apparent. Sec. 30 of the Act forbids any person related to any of the parties interested in the survey, within the fourth degree, from being chainmen, and in these settlements it was generally the case that every man was ruled out under this law, and so after cutting out the line the master and student had to chain it. The provision is entirely superfluous as the average farm laborer doesn't know enough to attempt to cheat; he couldn't cheat, if he would, if the head chainman knows anything about his business, and lastly, we have never yet met a farmer who had any idea of trying to cheat in a measurement. Farm boundaries in Canada must be run with a transit or theodolite, which of course always involves cutting out the line from end to end. In this new region the posts were nearly always standing and in good order, the distances in front were usually accurate and the work was generally very simple. We had a good supply of first-class axemen and it was rare sport to keep from four to eight and sometimes even more, sharp axes flying, and bringing down the great handsome timber or opening out the omnipresent cedar swamps. Our method of working was, after setting the front posts and turning a supplemental angle from our base, to set two pickets,—straight, peeled balsams,—the last one some 300 feet distant, then boxing up the transit and putting it in a safe place, set a tall, straight, peeled picket at the stake and run the balance of the line with a hand telescope. The student, after an hour's practice can run the line by eye and keep the axes in motion clearing brush and cutting the timber out of the way; one man, or if the timber is open and clear of brush, two, are needed to get pickets, trim, peel and point them for use by the surveyor, who comes along telescope in hand, or slung in a case, and examining the picket, selects the straight side and notches it, then selecting his ground with reference to what is ahead he sets the picket, plumbs it with a string and his telescope, or the plummet from the transit, tests it and corrects with his telescope until satisfied, and leaves it, to go forward and repeat the operation. The straight balsams, or white cedar and tamarack, can nearly always be found in Canadian forests and being white when peeled, can be set by eye so that, but for change of surface only the last picket will be visible. By this method the surveyor is always at the front; there is no chance for lazy men, and no shouting or frantic gesticulation and profanity, behind a distant transit, is necessary. Sometimes on account of abrupt changes of surface the instrument will have to be brought up, but the cases are not frequent. As a rule the timber was heavy and the cedar swamps dense and loaded with snow; we usually cut out one mile a day, for which eight dollars was charged and paid. In these cases no extra charge was made for a student's services, but by his assistance time was saved in cutting the line and in chaining. At the rear of these free grant lots along the roads the land is laid out in townships which will hereafter be described; the survey in these new parts was from the "proving line" which was blazed out every 100 chains, and the work was always very simple. The special training for this class of surveying was to cultivate the stomach until it would put an ostrich in despair, and next to that to take on a skin like a rhinoceros so that one could laugh at the little inconvenience of *cacæthes scribendi* and similar curtaneous disorders that keep the residents of those dismal regions in a constant state of eruption and activity, and in this connection we most respectfully suggest that, instead of burying untold sums of money under the snowdrifts, with the Canadian Pacific Railroad, that the benevolent politicians of the Dominion imitate the good Duke of Argyle, and do for the back settlements traversed by the government roads, what that benevolent nobleman did for his brother "Heelandmen." We would also suggest that a Society for Erection of Partitions in the houses be formed so that where three or four grown-up girls have to inhabit the same twenty feet square shanty with as many men some provision be made to protect the morals and spare the feelings of the latter. We found this department of surveying decidedly embarassing until we got used to it, and yet our experience was not even called for by the Board of Examiners.

The Burlington glass works at Hamilton, Ont., have been closed on account of the competition from the United States.

The "aerial torpedo" is one of the new ideas of modern warfare. A balloon is to be constructed capable of rising with a torpedo beneath it, and starting to windward of a camp or fortified city, is to be burst or detached by means which it would be easy to contrive, and then its cargo of death and destruction will fall into the midst of the enemy. The detachment of the torpedo may be effected with great ease by means of a thin electric wire, and the proper moment for dropping the charge, in order to explode it on any given point, will be only a matter of instrumental observation and a little practice.

GENERAL INTELLIGENCE.

☞ We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.

BRIDGES.

The city of East Saginaw, Mich., at a special election on the 24th ult. voted by a majority of 660 to issue bonds to the amount of $15 000 to purchase or build a free bridge across the Saginaw River.

An order for a new iron bridge at Athol, Mass., which was recently given to the King Iron Bridge Co., of Cleveland, Ohio, has been countermanded, owing to trouble in regard to patents, and the work given to Boston parties.

In the City Council of Council Bluffs, Iowa, on the 25th ult. the report of a Special Committee recommending that an iron bridge, placed upon wooden piles, be built across Indian Creek, at Bryant Street, in that city, was adopted, and the committee ordered to make a contract for the construction of the bridge.

The middle span of the Cincinnati, Georgetown & Portsmouth narrow guage R. R., bridge over the Little Miami River, about ten miles from Cincinnati, fell on the 24th ult., precipitating fifteen laborers a distance of forty-five or fifty feet killing three of them instantly. The accident is attributed to weak trestle work failing to sustain the superstructure.

The Memphis (Tenn.) *Daily Appeal* of the 28th ult. says: "Announcement by means of written posters is made for contracts to construct eight bridges over streams in this county. This is a cheap and indefinite method of advertising, for therein no specifications are made. However, the contractor who can interview the 'boss man' will be fortunate, for he may secure the contract."

The new iron bridge of the Keokuk & Des Moines R. R., over the Des Moines River, at Des Moines, Iowa has been completed, and was formally tested on the 18th ult. by L. M. Johnson, Chief Engineer of the road, and accepted by the Company. We extract the following description of the bridge from the Chicago *Railway Review*. "The sub-structure consists of six piers each of two clusters nine white oak piles thirty-five feet long driven to a plane forty two feet below the track. The piles, each one a foot square, are bolted together and cut off two feet below the top of a cylinder of half inch iron, five feet in diameter and twenty-four feet long, weighing ten thousand pounds. This is sunk six feet into the gravel bottom and then filled with concrete and capped with a cast bridge seat for the truss. The concrete and piles carry the load, while the cylinder and concrete preserve the piles from rot. Each cluster has to sustain 110 tons or 170 pounds per square inch of piling. The superstructure consists of five Pratt truss spans, 15 feet wide, 21 feet high, and 107 feet 4 inches between pin centers. An iron fence our feet high has been ordered, which, with the plank floor, will soon be in place. The material and workfmanship are first-class in every particular. The cost of the substructure and superstructure was $30,000, About $3,000 has been and will be expended in finishing with timber sidewalk and fence. The bridge was tested with two engines, completely covering each span. The deflection was found to be one-quarter of an inch."

RAILROADS.

An American palace-car, with dining-room attached, is doing a good business on a Belgian railroad.

The survey of the Fond du lac, Wausau & Lake Superior railroad is reported to be progressing rapidly.

A branch road is projected to connect Wilmington, Clinton county, Ohio, with the Marietta and Cincinnati railroad.

The survey of the Kingston and Pembroke railroad in Ontario, has been completed and located as far as the Madawaska river.

The railroad now running to connect the Union Pacific and Golden City, Colorado, is to be completed about September 1st.

Marshall county, Tenn., will vote on a proposition soon to subscribe enough money to extend the narrow gauge road from Lewisburg to Petersburg.

The Black Hills railroad survey corps which was recently camped on Running Water, 60 miles north of Fort Laramie, expected to reach Custer City about the 31st ult.

The contract for the construction of the extension of the line of the H. & N. W. R. R. from Jarvis, Ont., to Port Dover, a distance of eight miles has been let, and will be completed this season.

On the 1st of October trains will be running from Cheyenne over the Colorado Central railroad direct to Fort Collins, Longmont, Boulder, Georgetown, Denver, and all the principal cities of Southern Colorado as well.

According to the chairman of the Grand Trunk Railway, that road has lost $4,750,000 in two and a quarter years from competition, and railways in America have lost $47,000,000 in the same time from the same cause.

The citizens of Oskosh, Wis., are agitating the building of a line of railroad to connect with the Wisconsin Central at Menasha. The distance is a little over twelve miles and it is stated the probable cost will be about $100,000.

Some of the East India railways are being supplied with "punkahs" or huge fans, which are suspended in the cars by an iron rod, and are revolved by a Chinaman who sits on a platform outside the car, and is protected by a canvas awning.

The business men of Minneapolis, Minn., will be asked to contribute $50,000 towards the construction of the Minneapolis & St. Louis railroad. The towns along the proposed line of the road have almost unanimously voted in favor of its construction.

The Stanton branch of the Detroit, Lansing and Northern railroad will be extended this season to the north side of Day township, and efforts are being made to secure local subscriptions to secure its extension to Cedar Lake, a point on the St. Louis and Saginaw road in the west part of Home township.

A new narrow gauge road is projected to run from Columbus, Ohio, by the way of West Jefferson, Madison Co., and Mechanicsburg, to Urbana. Subscriptions to the amount of $20,000 have been secured in Urbana, which city is also to defray her part of the expenses of making a preliminary survey of the proposed line.

The cost of the 300 miles of the proposed narrow-gauge road (between St. Louis and Colorado), to be located in Missouri, is placed at $3,000,000 of which St. Louis is asked to furnish $1,000,000. A like amount is to be raised along the line of the road, and the other third is to be obtained from the sale of bonds.

The survey of the route for the proposed Boston, Albany and Schenectady railroad was to have commenced last week, the engineers commencing at Petersburgh, Rensselaer county, and surveying thence west to Buffalo. Another corps of engineers will soon be employed in surveying the route between Buffalo and Schenectady.

The Indianapolis and St. Louis folks have under consideration the erection of a depot at Indianapolis that will accomodate their freight business and also furnish offices for this department, the company only waiting the action of the other companies, who have proposed to unite and build a monster union freight depot on the west side.

In a distance of 54 miles on the Oroya (Peru) railway there are 61 tunnels. The "summit tunnel" is the longest (3850 ft.), and at an elevation of 15,648 ft. above the sea. Whenever necessary, the tunnels are lined with stone masonry. The line is on a 4 ft. 8 in. gauge. The rolling stock is American, most of the locomotives having been built at the Rogers Works, New Jersey.

The Xenia (O.) *Torchlight* says: "The preliminary survey for a narrow gauge railroad from a point on the D. & S E., six miles beyond Washington to Haydenville, Hocking county, has been made. It is proposed to strike the coal fields at a point several miles nearer than the Jackson county terminus of the D. & S. E. Three capitalists have given the project a starter with an aggregate subscription of $60,000."

Henry Meigs will have the line of the Cuzco Railroad in Peru finished as far as the ancient capital of the Incas by the end of the year. He is still continuing his three mile tunnel into the Cerro Pasco mines, situated on the side of one of the highest peaks of the Andes, and is pushing his railroad to the head of navigation on the Amazon, so that it is probable that in a short time Lima will be within three weeks of Liverpool, instead of being from six weeks to two months.

The Southern Pacific and the Central Pacific, the two great railroads of the Pacific coast, have joined interests lately and they have commenced grading the next 600 miles through Arizona to Tucson, where a branch will run to Prescott, the capital of Arizona and then straight on through the State to Ft. Bliss on the Rio Grande. The Southern Pacific will have intercommunication with the Gulf of Mexico and take freight from Matamoras and New Orleans direct to San Francisco, supplanting the Vera Cruz and Aspinwall routes and supplying all the forts along the Rio Grande from Santa Fe to Matamoras with troops and war material.

GAS AND WATER-WORKS.

It is asserted that Boston loses 16 per cent. of its water supply from bad plumbing.

The Walkerton, Ont., Council at its last meeting rejected a motion to raise the sum of $11,000 for a system of waterworks for the town.

The ratepayers of Peterboro, Ont., will shortly exercise their franchise on a by-law authorizing $50,000 to be raised for the construction of waterworks.

The completion of the recent contract for laying additional water pipe in Winona, Minn., gives that city a total of about eight miles of pipe and eighty-six hydrants.

In the Cedar Rapids, Iowa, City Council, on the 20th ult., a petition to have water mains laid across the river to the West Side was referred to the Committee on Water Works.

The Ottawa, Ont., *Semi-Weekly Citizen* says:—"Considerable opposition to the waterworks scheme at London, Ont., has already been developed. None of the papers support it, and no one is sanguine of its passage."

The City Council, of Columbus, Ohio, has given permission to the trustees of the waterworks of that city, to build such filter galleries as they may be able to, out of the earnings of the works.

It is reported that the St. Catharines, Ont., Gas Company are about completing arrangements with the Canadian Government for the lighting of the new canal between Thorold and Port Dalhousie.

Coney Island is evidently in need of a system of water supply, as we notice by the Flatbush, (L. I.) *Rural Gazette* that "the boys from the latter place pay daily visits to Coney Island, and sell water, bringing home quite a large sum of money."

A correspondent of the New York *Herald* asserts that "the Croton water is the worst drinking water in the United States and is positively injurious," and suggests that it ought to be possible to get good drinking water from the vicinity of Yonkers by boring Artesian wells.

The bids for the construction of waterworks at Peru, Ind., called for last month, have not as yet been opened. At a meeting of the City Council on the 24th ult., it was ordered that the engineer be employed to make plans, specifications and estimates of the cost of waterworks for the city. The Committee to whom the matter was referred, have employed J. D. Cook, Esq., of Toledo, Ohio, who is now engaged upon the work.

At a meeting of the Board of Aldermen of Nashville, Tenn., on the 24th ult., a proposition was received from Messrs. W. G. Bush & Co., to construct an aqueduct from the city waterworks to the filter at the island above the city, the distance not to exceed, at the most, 11,200, for the sum of $72,000; the entire work to be completed by the first of January next, if the contract is closed previous to Sep. 1st.

At a meeting of the City Council of La Crosse, Wis., on the 26th ult., which was called for the special purpose of considering the matter of power for the proposed system of waterworks and also to take action as to the laying of the necessary pipe, the Chairman of the Special Committee on waterworks, offered a resolution authorizing the Committee on waterworks to advertise for sealed proposals for steam power and pump-works, as soon as the pipes are laid on Third street; also, for laying pipes to connect the power with the system of pipes, and report bids to the Council; which resolution was unanimously adopted.

The City Council of Hamilton, Ohio, at their meeting on the 23d ult., adopted plans and specifications to govern proposals for furnishing that city with gas, both for public and private consumption. The contract is to commence June 3d, 1878, and to be for a period of ten years, the bond required from the party, or parties, to whom the contract may be awarded being in the sum of $25,000, bondsmen to be residents of the State of Ohio. In case the contractor erects new works, the city reserves the right to designate the locality where such works are to be erected. We do not learn that any limit has been set as to the time up to which proposals will be received.

The total receipts of the Boston Water Works for the year ending April 30, 1877, were $1,096,802, of which $1,029,000 was from sales of water. The total expenditures were $1,024,461, of which $209,902 was for current expenses, and $747,621 was for interest and premium on the water debt. The excess of receipts over expenditures was $72,340. The total amount charged to construction during the year was $2,129,779. It will be seen from this that even with a water debt of $12,000,000, the Boston Water Works are made to yield an income sufficient to pay the interest on the debt, their operating expenses, and afford a surplus of $72,000 a year for the reduction of the debt.

CONTRACTORS.

Grundy Centre, Iowa, has voted $1,200 toward building a jail.

A Toronto firm has secured the contract for building the new lighthouse at Port Colborne, Ont.

From eight to ten thousand dollars is to be expended in improving the Kincardine, Ont., harbor.

Resolutions to build a $25,000 sewer in the west end and a million dollar city hall are being considered by the Fort Wayne (Ind.) city council.

The new court-house at Winterset, Iowa, is approaching completion. It is built of stone, at a cost of $150,000, and is supposed to be fire-proof.

It is expected that the work of construction of the foundation of the new post-office building at Buffalo, N. Y., will be commenced in the course of a week.

The contract for doing the cut stone work on the new Union Pacific depot now in process of erection at Council Bluffs, Iowa, has been let to J. Pfeiffer & Son, of St. Joseph, Mo.

The contract for the erection of the Third ward School House in Akron, O., was awarded on the 24th ult., to Mr. Frank Lukesch. The cost of the building will be about $7,000.

The question of authorizing the Board of Supervisors to borrow a sum not exceeding $30,000 for the erection

of a court house and jail at Osceola will be submitted to the legal voters of Clark County, Iowa, at the next general election to be held October 9th, 1877.

Work in Canada on the Louisburg Railway and pier is progressing rapidly. Over three hundred men are at work on the track, and in some places double shifts are employed, such as the long swamp at Catalone.

The ratepayers of Howard, Ont., vote to-day on a by-law to appropriate $7,500 for the improvement of Morpeth harbor. The Dominion Government has promised to supplement the appropriation by an equal sum.

The Culbert Brothers will commence work in a few days with a large force of men, upon the entrance of Muskegon Harbor, Mich. The several jobs awarded them by the government, will nearly consume the entire amount of $10,000, the balance of the appropriation as yet unexpended.

The contractor has been obliged to suspend work on the new government building, at Grand Rapids, Mich., owing to the failure to receive the iron necessary for use in the structure at this time. The iron is at Pittsburgh, and cannot be moved until the railroad complications are ended.

Work has again been commenced on the main sewer of Windsor, Ont., and will be vigorously prosecuted to completion. The sewer is being built by the city for the purpose of employing a number of poor laborers who were out of work. It is estimated that it will cost $12,000 to complete the new sewer.

A correspondent of the *Thunder Bay Sentinel*, writing from the C. P. R. tunnel, says:—"The work in the tunnel under the supervision of Mr. James Meagher is progressing rapidly. Messrs. McKenzie & Chisholm have taken a contract for the heavy rock cutting on the northeast side of the Oskondiga, and will likely have a heavy force on there in a few days."

Hacket & Sperry, of this city, have furnished during the present season, over 8,000 feet of vitrified sewer pipe, ranging in size from 12 to 18 inches in diameter, to the city of Milwaukee. This firm handle the bulk of the pipe furnished the western trade, from the manufactory of Sperry, Ritchie & Co., of Tallmadge, Ohio, the largest single establishment in this branch of business in the United States.

MISCELLANEOUS.

Clinton, Iowa, wants a boulevard.

In 1876 Alabama exhumed 65,000 tons of coal from her depths.

A $20,000 Court House is what they propose having at Deadwood, D.T.

Dubuque, Iowa, is the only city in the west that has street cars run by steam.

Keokuk, Iowa, will expend $27,000 for improvements on her streets this year.

The use of the pneumatic system for underground railways is to be tested in London.

There is serious talk of draining Okechobee Lake in Florida, and reclaiming thousands of acres of land.

The commissioner of the U. S. General Land office has apportioned the sum of $17,700 for public surveys in Montana for the fiscal year commenceing July 1, 1877.

The United States government is having measurements and surveys taken to ascertain the feasibility of the long talked of ship canal across the Lower Peninsula of Michigan.

There are now in the oil regions of Western Pennsylvania eleven pipe lines for the transport of petroleum, with an aggregate capacity for continuous delivery of 30,000 barrels daily.

Chinamen are to be imported into Havana by a stock company recently organized to supply the planters with laborers. The capital is fixed at $2,000,000, half of which is subscribed.

Sheathing ships with paper fastened on with cement, is being tried at Portsmouth, England. A sea captain, who invented the process, claims that sea weed will not grow on, or barnacles adhere to the paper.

The total area of the New York Central Park territory is 937 acres. The extent of ground within the Park inclosure is 840 acres, 638 of which, including land and water, are given up to recreation.

In Durango, Mexico, there is a tin bearing district more than twenty miles in extent, which has 600 veins and 500 drifts of steam tin. The supply is so great that "metallic tin can be produced at a cost of two cents a pound."

Telephones are coming into use in Worcester, Mass. The Wellington Coal company has had a line put up, and the Washburn and Moen Manufacturing company has made a telephonic connection between its Grove street works and Quinsigamond. Private wires will also be put up.

The Belgian Government has ordered the construction of a new geographical map of Belgium. It will require seventeen years, and an expenditure of $282,100. The first instalment of the map will be exhibited next year at the Paris Exposition.

J. Bailey Denton, in his recently published work on sanitary engineering, has shown that the principal object of that art in dealing with sewage is to destroy the poison, and that the utilization of the refuse should be only a secondary consideration.

Virginia aspires to see the James river become the Clyde of the New World. The State has an abundance of coal and iron, and is not entirely unfamiliar with the art of ship-building, and some of her people see no reason why the James river should not be lined with iron ship-yards.

A bed of yellowish colored paint, covering an area of at least two acres, and having a thickness of four feet, has been discovered near Cullman, Ala. The paint is found to be superior to ochre, as it can be worked without adding white lead, and cannot be surpassed for watercolors.

Two of the largest silk mills in Paterson, N. J., have lately received an order from Paris for the manufacture of a certain description of silk goods. This is believed to be the first order received from Europe for American silks. If it is satisfactorily filled a considerable trade in this special line of silks is anticipated by the Paterson manufacturers.

The Nashville *American* calls attention to the mountain of silex near the Cumberland river, and within three miles of Hartsville, Tenn. For the manufacture of glass it is equal to any in the United States. The *American* adds: "Even the white sand generally used by painters here and elsewhere South is brought from the North, when it lies at our very doors and is ten times cheaper."

The Southern gold mines are rising again to prominence, the product of North Carolina for the fiscal year 1875-6 amounting to $10,335,000, and that of Georgia to $7,379,000, and that of South Carolina to $1,381,000 —a total of $19,096,000. The product for the year just closed is supposed to be greater. Eleven stamp mills are now running near Dahlonega, Ga.

In the last twenty-one years the Sidney mint in Australia has coined and issued more than 37,000,000 sovereigns; and the Melbourne mint has coined and issned nearly 7,000,000 sovreigns since it was opened to the public in 1872. These two branch mints together coined and issued in 1876 as many as 3,737,000 sovereigns, which is a larger number than the sovereigns coined in the year at the mint in London.

At a meeting of the City Council of Cedar Rapids, Iowa, on the 20th ult., the Commitee on Sewerage reported in favor of constructing a sewer on Iowa Avenue, not less than 18 inches nor greater than 30 inches in diameter, at a cost not exceeding $3,000, and the Committee on street railway reported in favor of granting the franchise to any company which will give sufficient guarantees to establish and operate a street railway in such way as the City Council may prescribe by ordinance. Both reports were adopted.

The large foreign trade of California in fruit and wines becomes no mystery when it is known that the State has 3,800,000 fruit trees and 35 000,000 grape vines, and harvests from 300,000,000 to 500,000,000 pounds of fruit yearly. She produces a large surplus, and foreign trade follows as a matter of course. Judging ftom the industrial spirit California displays, she will one day have a large foreign trade in manufactures from the same reason.

The following petition is in circulation at Detroit: The undersigned, believing in the importance of a speedy construction of a railway tunnel under the Detroit river, within the corporate limits of the city of Detroit, as at present constituted, or within two miles thereof, hereby promise and agree to pay to the tunnel company or association that shall within two years from the date thereof construct such a tunnel, the sums set opposite our respective names, provided such tunnel, when completed, shall be satisfactory to, and be approved by, the connecting railroad companies.

The Keokuk, (Iowa) *Gate City*, of the 24th ult. in referring to the partial completion of the improvements on the Mississippi River above Keokuk, suggests that the citizens should unite with the engineer corps in a public celebration on the occasion of the passage of the first boat. Regarding the work in question it says: "From the authorities in charge of the rapids improvement we learn that the canal will be so far completed as to admit of the passage of boats in about two weeks. The government steamer Montana will be brought down here from Rock Island and will be the first boat through the canal. The work has been going on now about nine years, millions of dollars have been spent upon it, and when completed it will be the most important improvement of the kind in the United States."

Gen. Simpson, Maj. Suter and Maj. Benyard, constituting the government commission of engineers on the Vicksburg, Miss., problem, have made soundings in the harbor of that place. The Vicksburg *Herald* says: "They favor the plan for protecting the caving banks of the Louisiana shore by carpeting them with willow mattresses from Grant's canal down to the Delta point, which would keep the channel where it now is; but of course this alone would not preserve our harbor. We presume they will determine whether a dredgeboat would be effective for that purpose, and, if not, will make a survey of the threatened cut-off at Paw-paw Island, and examine Old River and Chickasaw Bayou, with the view of bringing the Mississippi or Yazoo River into the lake, and thus establish a current in front of Vicksburg."

The Gaylord Rolling Mill Co., of Cincinnati, claim to have a process of making steel which is superior to the Siemens-Martin or Bessemer.

A ship which has just sailed from New York to Calcutta had a curious experience. She took her cargo on board on the East river, above the new bridge. Just before her departure the bridge cable was extended across the river, the highest point above the water being 172 feet elevation. This was not high enough to let the vessel's masts pass under unless she went to heavy expense by taking down the top-gallant masts; so to get out her captain took the unusual course of going out of the harbor by way of Hell Gate. The ship sailed through Hell Gate and Long Island Sound, and her owners are much gratified at finding the new route not only safe for very large vessels, but also much cheaper than the route by Sandy Hook. The bridge cable enabled them to save fully $150 by avoiding the pilotage, towage and other charges that are levied at the chief entrance to New York.

The Dubuque, (Iowa) *Daily Times*, of a recent date, has the following amusing account of an incident in connection with the repairs on one of the streets in that city: "First, the City Engineer was sent up to establish a grade, or rather, to drive stakes to show the whereabouts of the established grade. Saturday afternoon the Street Commissioner went up there and began to look around. 'Where are the engineer'sstakes?' he enquired of the forman of the gang. 'Oh, they are all right,' responded the foreman. 'But *where* are they?' persisted the Street Commissioner; 'I don't see any anywhere!' 'They are yonder, under the sidewalk, every one of them safe,' explained the foreman. And sure enough, he had pulled up all the stakes which the City Engineer had driven down to show where the grade of the street should be, and carefully laid them in a safe place under the sidewalk."

The New York *Times* in an article describing what has been done to remove some of the disadvantages, the port of Bristol, Eng., labors under, on account "of being approached from sea by a narrow, tortuous and shallow channel, accessible only at spring tides by small steamers of light draft," says: "The river Avon, within the past ten years, has had its bed deepened, its dangerous angles cut off, new basins have been provided, and a large dock built at Portishead at a total cost of over $4,000,000. Another dock for the city was opened this year at the mouth of the river Avon, a few miles below Bristol. The works have been nine years in building, and the cost of the dock, lock, warehouse, machinery and plant was $3,000 000. The basin of the dock contains a clear area of 16 acres, being 1400 feet long and 500 feet wide, with a depth of 26 to 32 feet, according to tides, so that larger ships can go in than can enter New York. The dock-gates are the highest in the world, having a depth of no less than 49 feet and a width of 70 feet. The dock itself is 600 feet long and 70 feet wide, with a depth of water of over 40 feet."

A remarkable piece of work near Yuma, Arizona, on the Southern Pacific R. R., is known as "The Loop," and many persons come long distances to see it. In laying out the line, the engineers found great difficulty in reaching the summit without exceeding the grade to which they had been restricted. They leveled here and there, and found they could only accomplish it by winding a long distance around and making several bends in the track. Colonel Gray found a way out of the trouble by making the road form a loop or circle upon itself, the first attempt of the kind in railway engineering. The road passes at a certain point into a short tunnel, and bends gently to the left; it goes on and on till at length, as you look from the rear platform of the train, you find yourself directly above the tunnel and discover that the track has made a loop around the mountain as perfect as the one you form around your finger with a bit of thread. The desired elevation has been gained, and the train is headed in the same direction as when it emerged from the tunnel, and almost exactly above the former position.

The question of a better and more efficient system of sewerage in Syracuse, N. Y., is receiving the attention of the citizens and press of that city. The Mayor has lately been making an examination of the condition of the present sewerage of which the *Daily Courier* says: "The results of his investigations are of a very serious, if not startling nature. In many instances it was found that sewers existed which absolutely had no outlets. In one locality it was discovered that a three feet sewer, discharged into a ten inch pipe. Nearly, if not quite half the tile sewers are broken and caved in and are nothing but huge stench traps sending forth deadly malaria into the outer air. This state of things is to be attributed to the fact that the past few years the construction of the sewerage of the city has been on the hap hazard order. There has been no intelligent, proper plan, but sewers have been loosely constructed, and improperly laid, with no heed given, in many instances, to outlets. Every tile sewer that has been laid is a humbug, and will be found to be utterly worthless. Nothing short of a complete overhauling and reconstructing of the sewers of the city can furnish an effectual remedy. On some of our most prominent streets, the stench arising from defective sewers is simply terrible, and something must at once be done to remedy the evil."

THE LAKE MEGANTIC RAILROAD.

It is some three or four years since the Lake Megantic Railroad was brought prominently to the notice of those sections most interested in its success, and it is only quite recently that the various parties have met for consultation. Within a few days J. H. Pope, M.P., Province of Quebec, president of the Lake Megantic R. R., C. C. Colby, a director of the same, G. W. Porter, of St. Stephens, N. B. president of the St. Croix and Penobscot R. R., and W. W. Sawyer, manager, had an interview at Bangor, Maine, with the directors of the Bangor and Piscataquis Railroad, to agree upon some plan of action which should push the enterprise to a conclusion.

The object is to open some shorter and better route than the Intercolonial Railway, between Montreal and some good port in the maritime provinces. At the present time it is, by rail, 859 miles from Montreal to Halifax. The new road of which we write is now built from Montreal nearly to Lake Megantic, not far from the line of the State of Maine, and its officers claim to be able to extend it to that line. Then about sixty miles of road are required to connect it with the Bangor and Piscataquis R. R. near Moosehead Lake. By following that line to La Grange, or perhaps to Oldtown, about forty-eight miles of new road, from either La Grange or Passadumkeag to Princeton, will make a junction with the St. Croix & Penobscot R. R., which runs to Calais and St. Stephens. Thence they may reach St. Andrews, St. John, or such other port as may be desired.

It is claimed that this new line will bring Montreal within 360 miles of a good seaport on the St. Croix, while Halifax and St. John would be over 250 miles nearer Montreal than they now are by the Intercolonial route. It is stated to be the straightest possible line between these places. The intercolonial trade and that of the upper provinces with Europe is counted on to make business for the new road. It is urged, as a reason for an interest to be taken by Bangor in the road, that it will make that place the depot whence a large portion of the merchandise purchased from the States for the Province of Quebec will be drawn.

The distances by different routes between Montreal and St. John are quite curious in their disagreement. By the Intercolonial line, built especially for the purpose of running exclusively on English territory, both as a military road and as a matter of pride, the distance is 761 miles; by the Grand Trunk Railroad, *via* Danville Junction or Portland and the Maine Central, it is 583 miles, while the new line will reduce it to between 500 and 480 miles, depending upon where the connection is made.

THE regular meetings of the Civil Engineers' Club of the Northwest will be resumed on the second Tuesday of September and continued thereafter monthly till the following June, as heretofore. During the past year the meetings of the Society were well attended and the actual strength and influence of the organization largely augmented. There is every prospect that the coming year will prove to be one of unusual prosperity and growth to the Society, and measures are already being taken by the officers of the Society and by the several Committees, to try if possible to interest every member, resident and non-resident, in the proceedings of the Club. At the last meeting a Committee was appointed to solicit papers to be read at the coming meetings, and members will soon be called upon to respond to a circular from this Committee. Heretofore this duty has devolved upon the Secretary, but this, in connection with the other business of the Club interferes materially with his regular professional duties, and the present Committee on papers is appointed to relieve the Secretary of some of his labor.

Engineers in common with other people are suffering from the pressure of hard times, but in the return to a more prosperous condition of affairs they will share in the general improvement. As in every business and profession, so in this, there are many men who have no claims by reason of their skill and ability upon public patronage; it should be the aim of the best men in the profession to join their influence in these Society organizations and make membership in them largely a criterion of professional ability. Who does not realize the standing that a membership in the Institution of Civil Engineers, England, gives to a Civil Engineer, and in our own country the American Society of Civil Engineers is coming to be recognized as a most influential factor in the body politic. Already there have been many valuable practical papers read before the Civil Engineers' Club of the Northwest, and now it is earnestly desired that this year each member makes it a personal matter to contribute *something* to the general fund of information. As far as practicable the Proceedings and Papers will be published in ENGINEERING NEWS, and through this medium much valuable information will be conveyed at once to thousands of interested readers in this country and in Europe. We will have more to say on this subject from time to time; we hope we may see an immediate response from every member of the Club.

WE would like to hear from any person who has a complete *Volume One* for sale. We also want the numbers for March 10th and 17th of 1877. Subscribers who are desirous of preserving complete files will do well to look after them at once as two or three weeks hence we will not have any numbers previous to July 1st. Subscribers who keep their files in good condition for binding at the end of the year can readily dispose of them if not wanted at that time. If you do not see fit to buy a reading case, make one of pasteboard so as to keep all the papers together. A little trouble now will repay you well. Without wishing to be boastful we are quite certain that the back volumes of this journal will always be in demand at a good price and subscribers will do well to make a note of it and act accordingly.

THOSE who wish to have their sheets bound should not delay a single mail, as the sheets have to be pressed and fitted for the binder, and the price depends very materially on the number to be bound. Also, if there are missing sheets to be supplied we wish to know it in time so as to print them. And how, after the postman has left twenty or more packages at once from as many different places, with illegible postmarks on each, are we to tell "who is who?" so please to attach the *printed* address label sent on your last paper on the *N. W. corner* of the parcel or we will not know whether your sheets come at all or not.

WE have a few copies of Volume Two of ENGINEERING NEWS still on hand, and which we would like to sell. These few are certain to be disposed of before the end of the year, but we want the shelf room which they occupy and the money which they are worth, and so would like to dispose of them quickly. The price is but *One Dollar* which is ridiculously low for such a book and we hope it will be appreciated by those who should have it.

ERRATUM.—On page 195, second column, line 47, for *subsiding* read *subsidiary*.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

IV.

Stretching along the north side of St. Lawrence river and Lake Ontario is a narrow strip of land, perhaps 60 miles wide, under which, together with the peninsula lying west of a line from Toronto on Lake Ontario, to Collingwood on Georgian Bay, comprise the great bulk of the arable lands of the Province of Ontario. All back of this is covered with forests of pine, hemlock, tamarack and cedar, but principally of the first named timber, and from which a very considerable portion of the Dominion revenues are derived. In truth very nearly every business in the Dominion is interested more or less directly in the lumber trade of the country and to the Provincial Land Surveyors of the Ottawa districts the patronage of the lumbermen is a very material item in their yearly incomes.

The Lyons House at Arnprior was always a favorite rendezvous of the lumber princes of the Ottawa, and by reason of forming the acquaintance of some of those who were passing to and from their "shanties" in the pineries, my master soon had orders for the survey of several "limit" lines, and long before daylight one gloomy March morning in 1861 we left our hotel, bound for the "shanty" of the Messrs. G. & W. Shylock about 90 miles up the Madawaska river. After passing around a rapid some sixteen miles in length the only road was on the ice, with occasional short reaches on shore to get around the open water of several other rapids; there were but two or three houses in the whole distance; the river was broad and from the smooth ice all marks of a roadway were frequently obliterated; a drizzling rain came down all day long, and after losing our way twice in the deep bays of the river, we reached the residence of our patron at nine o'clock in the evening after a drive of 70 miles, wet to the skin through our thick overcoats, and nearly famished. Next day we pushed on to the lumber camp—or "shanty" as it is always called—only some twenty miles distant, but by reason of the camp having been very recently moved, and our becoming entangled in the labyrinth of timber roads, which, drive where we would brought us back to the deserted camp, it was only by retracing a part of our way and making inquires that by 9 P. M. we succeeded in pulling ourselves and team through the deep snow of a new and unbroken road, to the shanty, where we soon revelled in the warmth of a huge fire, while we partook of a liberal allowance of fat pork, baked beans, bread, and strong tea, and afterwards the sound sleep that a thoroughly exhausted man can heartily appreciate. I mention these apparently trifling incidents, as they are thoroughly illustrative of a surveyor's life in Canada, and I am now sketching out a small portion of the actual experience of my student life during which time I was giving my services gratuitously, and paying all my own expenses of living besides. Whether or not the acquired information justifies the expense and labor, I leave to be decided by each of the readers of those papers, for himself.

A Canadian timber "limits" is a tract of land *leased* by the government to any individual, and his heirs, for the purpose of cutting the timber therefrom. The price in 1860 was about one cent per cubic foot of timber, and one thousand cubic feet, or twelve thousand feet board measure per acre, was an extra good yield, while five thousand of the latter was an average. These tracts were of varying sizes, fronting always on a river or a lake, and from ten to twenty and even more miles of such frontage, and running, practically, at right angles from the river back to a prescribed distance as given by deed from the government. The boundaries of these limits usually commenced at some prominent point or headland in the river or lake and were run by compass the given distance determined by chaining.

Oftentimes one owner would be tempted by the fine timber to go outside his own limits, and he might be despoiling his neighbor for two or three seasons before the question of ownership was mooted, when the skill of the surveyor was brought in to settle the point and decide who was to count stumps and bring in a bill for the missing pines. It was on just such an errand as this that we were summoned. The west line of the limit started from a big pine on a certain described point on the river bank, which we were shown (but about which I feel certain that there was a great deal of uncertainty), and it was to run on a given bearing fifteen miles to Lake Clear, and thence five miles eastward, at right angles, to some other point where everything else melted into oblivion. There had been several surveys previous to our coming, but they had effected no results satisfactory at least to our clients, whom I believe were about as detestable pirates as there were in the business of timber stealing.

A lumber camp or "shanty" is a log structure, about 25 or 30 feet square and eight or ten feet high, with an opening in the roof about 8 feet square to let out the smoke from the open fire-place beneath. The openings between the logs are well closed with mud, and around the sides of the building are placed the "bunks" of the inmates. These are continuous, and are made by driving round poles at regular distances and about seven feet long into the logs two tiers high and supporting them at the outer ends by other and larger saplings, and after staying these uprights, the intervals are floored over with small poles upon which hay and blankets are spread for the inmates to sleep upon. A space is left for the door of the shanty, and a portion for the cook's department. Around the outside of these bunks runs a line of benches, and a couple of feet away is the broad open hearth, a raised mound of earth confined by stones around its sides and being about 8 feet square, and upon which a huge log fire is always blazing and

into which the refuse crusts of bread and pieces of pork are thrown by the timber makers who occupy during meal times, and through the long evenings the row of benches. It was a novel sight to me when, for the first time, I stepped into a Madawaska lumber shanty, and met the quiet gaze of some forty swarthy Canadians turned, some from their chequer-boards, others from packs of dirty cards, and some from the beads which, on bended knees, in their bunks, they were counting, before lying down for the night, but all lighted up by the glowing fire which imparted cheerfulness and warmth and light — and smoke — throughout the entire enclosure.

The men in this camp were French and Scotch Canadians, the former who are the very best timber makers in the world being in the majority; the latter were the teamsters, road cutters, etc., of the company. The timber makers are organized into gangs of five men each, a hewer, a liner, and three scorers, the first two select the trees, then fell them, trim, line and hew them, and they are followed by the scorers. In a camp of 30 to 40 men there will be four or five gangs of timber makers, and a day's work of a gang is from 300 to 500 cubic feet of square timber. The men go to the woods from September 1st to the middle of November and as soon as the creeks and rivers open in the Spring, the "drive" commences, and it is kept up every day without intermission until deep water is reached and the timber is safe from lodging, when it is made into rafts and floated to market. Through the lakes where the ice is thick a narrow channel has frequently to be sawn for miles, through which the timber, two pieces abreast, is pushed as rapidly as possible. To wait for the ice to melt would involve the probable loss of the winter's labor by the rapid fall of the rivers after the spring freshets. The running of the limit line was a very simple affair; we were furnished with three French Canadians; two to cut brush, and one to assist in chaining, and the foreman of the camp having shown us the starting point we had only to run the fifteen miles on the proper bearing. Two of the men rebelled after the first day's work, but as the discipline is pretty severe the only choice for the "strikers" lay between paying for *our* lost time till *they* were ready to go back to work, or to leave the camp, and trudge a hundred miles or more to their homes, or to Quebec where they would claim their wages when the raft came into market. It costs considerable money to transport men to these remote and almost inaccessible regions, and to prevent mutinies and strikes the lumbermen have always had most sumptuary laws enacted giving them absolute control over their employees until the winter's product is safely moored in Quebec Cove. The average French Canadian *habitant* is but a grown-up child and is about as reasonable as a child; these poor fellows, who "got their backs up" about nothing actually took up their little bundles and abandoning their winter's pay started for their homes in the Lower Province rather than go back to work with the surveyors.

There was nothing for us to do but to sit around, or lie in our bunk, and read the books we had brought with us, or ask questions about timber-making, until after one of the partners arrived, when another gang was broken up and we were started on our line again The snow lay on the ground from three to ten or fifteen feet deep according to the irregularities of the surface and the amount of the winter's drifting, and it was growing daily more slushy and heavy beneath the warm sun and drizzling rains of the March days. We of course, worked on snow-shoes and made a couple of miles per day, as a good deal of brush had to be cut and a line blazed very distinctly so as to permit an accurate count of stumps. An incident occurred on the evening of the fourth day that is worthy of mention. We had got to a point about eight miles from camp at the close of a very wet afternoon, halting only in time to allow us to get back to the shanty by six o'clock. My master and myself this evening struck out for a small lake a couple of miles distant, crossing which on the ice we made our way to camp down the stream which led to the river near which the camp lay; the *habitants* were to return by the blazed line which, if followed, would bring them by the shortest route to camp, and being expert woodmen they would have no difficulty. Darkness came on early, but we two reached the shanty in safety, although very wet, but nine o'clock came and no axemen, and at ten there was quite a sensation on account of the non-arrival of the unfortunates, while all the time the cold March rain was coming down with unremitting drizzle; but finally the three arrived, and while they were laying away an extra ration of pork and beans and scalding tea, they related in the most animated *patois* how one of the three was a victim of "night blindness," that is, could not see after dark; so the other two had to lead him all the way, but after pitching and stumbling over several fallen trees, which is no light matter when on snow-shoes, they had lost the blazed line, and had been wandering about in the forest with their blind companion in charge until they had recovered the line and finally dragged him to the light. Some people do not believe in "night blindness," which, we were given to understand, was occasioned by the protracted salt diet of the lumber camp, and I give this case simply as it came under my own observation in March, 1861. We all slept soundly that night, but it having become inconvenient to return to camp so many miles, it was deemed expedient to go prepared for camping on the snow wherever nightfall found us. Another *habitant* was detailed, to whose stout shoulders were strapped a frying-pan, a tea-kettle, and six tin cups, bread, pork, and tea, for six hungry men for three days, and a blanket each for himself and two comrades; the chaining was discontinued, and I was detailed to carry two heavy Indian blankets; the partner, who accompanied us, carried his own blanket; the surveyor and axemen, after we reached the end of the line already blazed, were left free of all incumbrances. We had an easy time of it; even the man with the camp on his back enjoyed it, while we three burden-bearers strolled along leisurely after the surveying party, or squatted on our snow-shoes and smoked the strong "plug" tobacco of which the economical Canuck always has a store in his breeches pocket. When it became too dark to see the wires of the compass sight, a halt was called and in a surprisingly short time the *habitants* had selected a camping ground, erected a "lean-to" thatched with hemlock boughs, and with the same fragrant evergreen carpeted the interior, and spread the blankets; "punk" had been found and a roaring fire of dry hardwood logs was sending up its cheerful blaze, while the festive frying pan and the hissing teakettle were doing their level best to contribute to the general good feeling of the occasion.

Water was got from the melted snow; thick slices of shanty bread supplied plates which did'nt need to be washed after using, the same knives that cut the plug tobacco were good for salt pork, and with our tin cup we were thoroughly furnished; what more could a reasonable man want except an appetite, and there was no lack of that. For dessert we had the tobacco, under the soothing influence of which all eyelids soon felt heavy and at a most seasonable hour, with our feet to the fire, and a single blanket for a covering, we were engaged in the most lively serenade those tall pines ever listened to. When we awoke at early dawn our fire was still aglow, but about five feet below the level of the surrounding surface which made it a little inconvenient to breakfast by. We reached the settlements of the Opeongo Road that day and slept on the floor of a lumber shanty near Lake Clear that night, but next day abandoned the work, as our predecessors had, and while my master strolled off home some seventy miles distant by the Opeongo, I snowshoed back to the lumber shanty to bring back our horse and sleigh. For the benefit of any of my readers who should ever find himself and team suddenly let through the ice into a deep river I will relate my experience in leaving this miserable locality. I had a drive of twenty-two miles to make to the only stopping place for the night, the partner who had been with us shared my sleigh a part of the way, but as we took the river the shore ice having become rotten, let us all through and we were at once in water quite beyond our depth, with a single horse, and two men in the sleigh, in which were also our transit and some luggage. There was no returning and no other road out; my companion, who evidently had seen such things before, took the reins and the whip and our poor beast had to break ice until it would hold him, when he clambered out and pulled us after him, sleigh and all. The next evening I was at Arnprior, I have never been on a limit survey since and and I never want to be. What we did was a fair sample of that class of Canadian surveys, and all the information concerning actual land surveying to be obtained from a life time of such practice can be had in a day's time in any piece of timber with any old compass for an instrument.

THE JAPAN LIGHTS.*

BY RICHARD HENRY BRUNTON, M. INST. C. E.

(*Continued from page 197.*)

The Author arrived in Japan just at the completion of the civil war, which revolutionized the country and gave Europeans a more secure footing in it. He then found the various Government departments in a disorganized state. The lighthouse work was transferred from one to another, and at various times was in charge of about eight or ten different sets of officials. It so became difficult to organize the service, or to arrange or enforce any rules or regulations. At the time of his arrival no artisans were acquainted with anything beyond the slight and unimportant work customary in the country. Carpenters were skilfull in the use of their tools, but masons, bricklayers, and blacksmiths were almost unknown. Men had therefore to be taught each of those trades, and the works had to be carefully watched during their progress. The staff of Europeans employed has been extremely small, but notwithstanding the difficulties surrounding the prosecution of the works, each lighthouse is well finished. There have been no signs of failure of any importance, and the earthquakes which have occurred since their erection—one or two were severe—have had no visible effect upon them.

The Author has received most flattering assurances of the high appreciation in which the lights are held by nautical men who frequent the coasts of Japan; and great credit is due to the Japanese Government for the liberal manner in which it has prosecuted the work.

APPENDIX II.

Expenditure incurred by the Lighthouse Department from the date of its establishment, August, 1868, to the end of 1875.

Name of Light.	Date of Commencement.	Date of Completion.	Height of Lower to centre of Lantern.	Material.	Cost.
			feet		Dols.
1. Shinagawa	Feb. 1873	Apr. 1873	19	Brick	2,054
2. Yokohama Harbor	Jan. 1874	Mar. 1874	40	Wood	245
3. Haneda	Mar. 1874	Mar. 1875	55	Iron	14,000
4. Kannonsaki	Oct. 1868	Dec. 1868	40	Brick	8,182
5. Tsurugisaki	Mar. 1870	Mar. 1871	25	Stone	34,444
6. Noshimasaki	Mar. 1868	Dec. 1870	99	Brick	22,590
7. Inuboyesaki	Feb. 1872	Nov. 1874	90	do	44,825
8. Kinkasan	Mar. 1874	.	24	Stone	45,100
9. Siriyasaki	June, 1873	..	92	Brick	61,300
10. Awomori	July 1874	Nov. 1874	40	Wood	424
11. Ishinomaki	Dec. 1873	Feb. 1874	40	do	424
12. Noshiaf	June 1872	Aug. 1872	31	do	2,519
13. Nemuro	May 1872	Aug. 1872	40	do	424
14. Jokashima	July 1870	Sept. 1870	19½	Brick	2,000
15. Mikomoto	Apr. 1869	Jan. 1871	60	Stone	107,530
16. Irosaki	July 1871	Oct. 1871	20	Wood	2,430
17. Omaesaki	June 1872	May 1874	57	Brick	33,340
18. Sugashima	Feb. 1872	July 1873	25½	do	8,912
19 Matoya	Oct. 1871	Sept. 1872	36	Wood	13,023
20. Kashinosaki	Apr. 1869	Aug. 1870	15	Stone	40,229
21. Shiwomisaki	Apr. 1869	Oct. 1870	63	Wood	50,253
22. Tomagaishima	May 1870	July 1872	21	Stone	22,963
23. Temposan	Dec. 1870	May 1871	30	Wood	6,500
24. Wadanomisaki	Oct. 1870	May 1871	46	do	13,517
25. Yesaki	May 1870	May 1871	15	Stone	28,119
26. Nabeshima	Dec. 1871	Feb. 1873	21	do	7,910
27. Tsurishima	Oct. 1871	July 1873	21	do	18,823
28. Hesaki	Dec. 1870	Apr. 1872	21	do	20,204
29. Rockuren	Dec. 1870	Dec. 1871	25	do	23,710
30. Kadoshima	Aug. 1873	..	87	do	52,000
31. Shirasu	Mar. 1872	Mar. 1872	42	Wood	9,239
32. Yebosishima	Aug. 1873	Aug. 1875	44	Iron	69,400
33. Iwoshima	June 1869	Jan. 1872	23	do	21,020
34. Satanomisaki	Jan. 1870	Dec. 1871	20	do	66,838
35. Yokohama Bay.	Dec. 1868	Dec. 1869	..	Wood	29,645
36. Hakodate Harbor	May 1870	Apr. 1871	..	do	20,260

BUOYS (including spare ones).

Yokohama, 3 buoys, 8ft. high	$2,379
Kawasaki, 3 buoys, 8 ft. high	2,379
Saratoga Spit, 2 buoys, 15 ft. high	3,320
Shimonoseki, 5 buoys, 8 ft. high	3,965
Hikushima, 3 buoys, 9 ft. high	2,370
Hiraiso, 2 buoys, 12 ft. high	2,433
Motoyama, 2 buoys, 12 ft. high	2,433
Ainoshima, 2 buoys, 12 ft. high	2,433
Total buoys, 22.	

BEACONS.

Manaita, commenced April, 1871—completed September, 1871; Narusi, commenced and completed same time; Yodsibi, commenced and completed same time	$ 1,527

*Paper read before the Institution of Civil Engineers, London.

Lighthouse establishment, offices, and dwellings	66,237
Total cost of construction	1,003,889
The purchase of the steam tender and her maintenance, the payments of all salaries to both European and Japanese officials, and various other miscellaneous expenses connected with the establishment amounted to	1,050,000
The maintenance of the various lighthouses amounts to	189,000
Making a grand total of	$2,242,889
Or about £450,00 laid out on the lighthouse work up to the end of the year 1875.	

Messrs. Stevenson, having been intrusted by the Board of Trade to advise as to establishing a light-house system for the coast of Japan, and to select and recommend for appointment engineers, foremen-mechanics, and trained lightkeepers to carry out their recommendations, desired, through the Secretary, to acknowledge the valuable services of Mr. Brunton, who had been selected for the office of Chief Engineer, in carrying out their designs. The author of the paper had not adverted to certain preliminary matters (probably because they occured in 1867, before his appointment), which explained correctly what led to the adoption in the first instance of catadioptric instead of dioptric apparatus, and rendered it unnecessary to offer any observations on what the author had said as to the comparative advantages of the dioptric and catadioptric systems of illumination, as to which lighthouse engineers did not differ in opinion.

These preliminary matters referred to the authenticated effects of earthquake shocks, to which attention had been drawn in all the reports sent from Japan to the British Government. In transmitting these reports to the Messrs. Stevenson, the Board of Trade specially requested them to consider in what way the anticipated injury to the apparatus could be ameliorated. The Elder Brethern of the Trinity House, who had also been consulted by the Board of Trade suggested the employment of Holophotal reflectors as the safest apparatus that could, under the circumstances, be employed, a recommendation in which Messrs. Stevenson entirely concurred. As an additional safeguard they proposed the introduction of an 'aseismatic' arrangement. This, as applied to the apparatus, consisted of a slight alteration of the table on which the reflector flame and machine rest, and a cost of about £90 for each lighthouse. Messrs. Stevenson were confirmed in their recommendation of this simple expedient from satisfactory experiments made in this country, which proved that violent shocks applied to the lower part of the table, failed to affect apparatus resting on it, so long as the aseismatic joint was in operation; but that whenever the table was screwed down, so as to form a rigid mass, the same shock not only threw off the lamp glasses, but in some cases extinguished the lights. Fig. 1 was a section in which the upper table bearing the holophotal reflectors was shown in hatched lines. This table rested on balls contained in cups formed in the upper and lower tables. Fig. 2 was a plan showing the points of support which, for ease of adjustment, had been made at three places dividing the circumference of the table into three equal arcs.

In furthur illustration of the subject, and particularly of what had been done in Japan, Messrs. Stevenson gave the following quotation from their Report to the Japanese Government made in June 1876, after the authorized works had been completed:* "In all the documents," the report states, "which were submitted to us for consideration by the Board of Trade in 1867, whether from the French, American, or English authorities, great prominence was given to the prevalence of earthquakes, and their anticipated effects on the proposed lighthouse works. Captain Bullock, R. N., calls attention to the frequent volcanic shocks, and says, 'Engineering skill will be required to provide against them.' The French naval officers report that earthquakes, so frequent in Japan, 'would prevent the use of stone structures,' and the Trinity House report 'that perhaps the greatest difficulty of all will be found in the constant volcanic disturbances common in Japan.' To meet the difficulty which had been raised Mr. David Stevenson suggested the use of an 'aseismatic joint' in the table supporting the lighting apparatus, so contrived as to admit of a certain amount of horizontal movement taking place in the lighthouse without effecting the table on which the apparatus rests. This arrangement was proved on experimental trials made in this country to be successful, and it was introduced into the Japanese lighthouse apparatus. It would appear, however, that from some dislike to the unsteadiness of the apparatus during the process of cleaning, the aseismatic joint was secured so as to prevent it from acting; and, with the apparatus in this state, the only recorded earthquake which has effected any of the lights occurred at Segami, which is lighted by twenty-one holophotal reflectors. The shock had the effect of throwing the whole of the lamp-glasses out of their places, and disarranging the working of the machine, and the opportunity of testing the effect of the apparatus (as an amelioration of an earthquake shock) was thus lost. The experience obtained since the light-houses were established has certainly gone to prove, that earthquake shocks have neither been so frequent nor severe as was represented; but it should be kept in view that such visitations are extremely uncertain, and may return at any time with renewed frequency and increased vigor. We should, therefore, suggest that if it be desirable to make the tables *less sensitive*, that this could easily be arranged without rendering them incapable of motion; or if it be considered desirable to screw up the tables while the apparatus is being cleaned, the screws should be made so as to be undone when that operation is completed, so that the responsibility for the action of the aseismatic apparatus should lie with the lightkeeper and not with the lighthouse authorities. The serious damage of any of the lighting apparatus by earthquake shocks, would entail undesirable responsibility if it should occur in a case where the aseismatic joint was found to have been permanently screwed up so as to prevent its acting."

Messrs. Stevenson had great pleasure in saying how much they were assisted by the valuable advice of Admiral Bedford, of the Board of Trade, in determining the positions and the characteristics of the most important of the sea lights; as well as in arranging the various details for giving the Japanese authorities the aid asked from the Government of this country in establishing their lighthouse system.

Mr. Douglass observed that, this being a case of the first lighting of a large extent of coast line, he should be glad to hear some explanation as to the large proportion of fixed to revolving or flashing lights. It was well known that revolving or flashing lights had an accumulative power from five to ten times greater than fixed lights, with the same consumption of oil; in other words, the annual cost for oil with a revolving or flashing light was from one-fifth to one-tenth of that of a fixed light of the same power. In first lighting a coast like Japan, an essential consideration would, therefore, seem to be to introduce as many revolving or flashing lights as possible, having due regard for the necessary distinctions to prevent one light being mistaken for another. The fixed light was considered to be the least distinctive, and should only be adopted where it was desirable to use coloured arcs to cover local dangers; but that appeared, from the Paper, to have been done only in three cases. Out of thirty-four lights only five were revolving. He thought that, as a provision against earthquakes, a light wrought iron, or wooden structure would be preferable to one of stone. If the stone structure were low, as in some of the instances described, it might, no doubt, withstand a heavy shock; but, for a tower 80 or 100 feet high, a light iron structure, or one constructed of local timber, would have been less costly and more stable. If the earthquake shocks in Japan were as serious as had been represented, he should prefer the old catoptric revolving light. With this light the consumption of oil for the same amount of light would be greater than with a dioptric revolving light, but less with a dioptric fixed light, while the first cost of the apparatus would be much less than that of a dioptric light, either revolving or fixed. With earthquake shocks these lights would be as safe as any building that an engineer could design. Evidence of this had been furnished by the forty-seven light-vessels in the service of the Trinity House. These vessels were all fitted on the catoptric system. In some collisions, the lantern and illuminating apparatus had fallen from the mast-head to the deck, a height of 30 feet, but in no instance had the apparatus been entirely destroyed. Under such circumstances, a dioptric apparatus would have been completely broken to pieces. A fixed catoptric apparatus was almost out of the question, except where very small arcs were required to be illuminated, because it was impossible to produce a well defined cut between white and colored arcs. It was stated in the Paper, that in the Doty burner, "volume for volume, mineral oil is superior to colza oil to the extent of one-fourth more light in the first order lamps, two-fifths more in the second, one-half more in the third, and four-fifths more in the fourth order lamps." From his experience with the Trinity House lamps—while the highest recorded photometric results with the greatest economy of working had been obtained—he had found that volume for volume there was no superiority in the best mineral oil over the best colza, but rather a small percentage in favor of colza; moreover, with colza oil these lamps burned almost uniformly for sixteen hours, with only the usual occasional regulation of the damper, but without any trimming of the wicks. The only known advantages of mineral oil over the best vegetable oils, including cocoa-nut, which was as good as colza, were its readiness of ignition, its flame more rapidly rising to the maximum power, and in some cases its low price—the present price in this country being about two-thirds that of colza.

Mr. W. Lloyd said, having had some experience in the construction of lofty buildings in countries liable to earthquakes, he thought there was a great deal more fear with regard to the effects of those shocks than was at all justified. He should like to give two instances that had come under his own observation bearing on the movable joint that had been proposed. As he understood it, this would allow of a limited horizontal movement, and of a free vertical movement. The first case was that of a church-tower in Mendoza, which had been almost entirely destroyed in the year 1861. Two storeys out of three remained after the earthquake. The lower storey was more or less intact, except that there was a large crack in it. The upper storey was entirely destroyed; but the middle storey, by some horizontal movement was turned round nearly one-half upon the lower storey, so that the angles of the upper storey corresponded more or less with the centre of the side of the lower storey. That showed an amount of horizontal movement which would be dangerous with a joint of the description proposed. With regard to the vertical movement in the case of an earthquake, he would cite an instance that occurred in Valparaiso in 1851. A family party were sitting in a room after dinner, and on the table was one of the old-fashioned oil lamps, with a large globe and a chimney-glass within it. An earthquake took place, the family rushed out, and on their return they found the globe on the ground; it had been thrown over the chimney-glass, which remained in its place. One could easily imagine, therefore, what the effect would be in a lighthouse, if the joint had a vertical movement. The lantern might be destroyed. From his experience of the structures erected by the Spaniards, he believed that the more solid the structures, the better they resisted earthquake shocks. In Panama there was a single-stone arch of an old Spanish church, spanning 40 or 50 feet, and it remained to the present day. On the Pacific coast, numerous bridges had been built by the Spaniards with solid stone arches, which had resisted every earthquake, not a crack being visible in them. He believed that Nature had pointed out the best course to pursue in structures of that kind. In the lighthouses described, so far as he could judge from the illustrations, there was one defect—a want of batter. Every structure that he has erected in an earthquake country had a great deal more batter than would be given to a similar structure in England. The broader the base the better. An analogy might be found in the buttress-tree, which spread out on all sides in a manner remarkably like buttresses.

Dr. Pole could testify, from correspondence he had had with Japan, how highly Mr. Brunton himself and his work were valued by the Japanese, and by his brother engineers in that country. He had placed upon the wall a Japanese map on a large scale, which had been recently sent to him by Mr. Boyle, the Chief Resident Engineer of the railways, who has marked upon it the lines executed and projected. He thought,

* Report to the Imperial Government of Japan, relative to lighthouses by D. and T. Stevenson, Civil Engineers, Edinburgh, 21 June, 1876.

at some future time, a Paper upon Japanese railways might be interesting to the members of the institution. He had also placed upon the table some photographs of railway works in Japan. The country was no doubt a land of earthquakes. Near Yokohama there was a celebrated conical mountain Fusi Yama, always seen in Japanese lacquer-work, very high and visible at a long distance. It was a volcano, which had been in action within the historical era, but it was now extinct. The volcanic influence, however, remained, and the country, especially in that particular neighborhood, was very subject to earthquakes. He need not say that that liability had attracted the attention of the railway authorities, who had endeavoured to make their works strong enough to withstand the shocks. A great many bridges were required, and many of them had been constructed of iron sent out of England. In their design the probable effects of earthquakes had also been considered. But there had been no shocks of importance since the railways had been opened, and experience had therefore yet to be gained.

Mr. Abernethy, Vice-President, observed that probably there was something special in the character of the Inland Sea, otherwise he could not agree to the principle laid down by the Author, to put no lights where the headlands were bold and well defined, or where no danger existed. In this country the most important class of lights were those placed upon salient headlands, in order that during on-shore gales vessels might have a good offing, and ascertain their proximity to land as early as possible. The system of lighthouses might be divided into three parts: 1, the lighthouse upon prominent headlands; 2, lights to define the position of harbors; and 3, guiding and leading lights to guide vessels into the harbor. He could not gather from the Paper that this order had been observed. With reference to the effect of earthquakes, he was of opinion that weight and solidity, and not slightness of structure, were best adapted to meet shocks of that description. An extraordinary example was that of the great aqueduct from Cintra to Lisbon, which at one point was at least 250 feet in height, and which was within the zone of the great earthquake that destroyed nearly all the principal buildings, when this structure was uninjured and remained intact to the present day. This fact among others led him to believe that, in order to meet the shock of earthquakes, solidity and weight were essential elements.

Mr. Woods said he had been engaged in the construction of buildings for Peru, where earthquakes were very prevalent, and he had always understood, from the information he had received, that buildings of slight construction, whether of wood or of iron framing, were better adapted to resist earthquake shocks than more solid erections. He could mention cases in which light structures had stood very severe earthquake shocks. For instance, at Pisco, a small town on the coast of Peru, exposed to action of the sea with heavy surf, there had been built from his designs, about twenty-five years ago, a light wrought-iron pier, with screw piles, extending 2,400 feet out to the sea. Six or seven years ago a great earthquake occurred, by which the city of Arica was overwhelmed. A wave of the sea rushed into the town, carrying with it a gunbrig ½ mile in shore, where she now lay high and dry. The pier sustained the shock of the earthquake. The motion of the platform was so severe, that persons could not stand steadily upon it, but the pier suffered no injury whatever, the undulations passing through it without affecting its stability in any way. He believed the pier was now as sound as when it was first erected. He might mention another instance, that of a building erected at Payta, also on the coast of Peru. It had a light iron framework, lined with wood, and it had been in existence twenty-five or thirty years, after sustaining every shock that had occurred in that part of the country. He did not know whether there had been sufficient experience to test the effects of earthquakes on the solid lighthouses in Japan, but he was inclined to think that a severe shock might occasion them considerable disturbance. With regard to the proposal to fit the lighthouse with lantern tables, he thought an elastic fixing would be as serviceable as the method described in the Paper. If the platform to receive the lanterns were secured to a propor table, by means of intervening springs, he believed all the effect supposed to be obtained by a ball and socket joint would be obtained.

Mr. Beaumont said with reference to the partial revolution of one portion of a building upon another, it had been shown by Mallet, in his various works on the phenomena of earthquakes, that it was due to the difference between the fractional adhesion of one part of the building and that of the other, the inertia of the building allowing that part that was not as well fastened as the other to remain nearly still while the other part or parts moved backwards or forwards in the first or second phase of the shock. In the case of lighthouse structures, where the different courses were properly dovetailed one into another, of course that would not take place; neither would structures built of iron be subject to any such movements.

Mr. Brunton, in reply, said one reason for the large proportion of fixed lights was their greater simplicity, a matter of importance in a country like Japan; but it should be understood that only part of the scheme for the illumination of the coast had at present been carried out; in order to introduce the necessary distinctions, the lights still to be established would be chiefly revolving. The natives would by that time have gained experience, and might be intrusted with a revolving machine; but, at the commencement of the undertaking, the importance of having a simple apparatus could not be exaggerated,

Doty's burner was adopted in Japan in 1872, on account of the difficulty experienced in procuring suitable vegetable oils, and because at the time no other suitable mineral oil burner was available. Subsequent improvements in burners by Mr. Douglass tended to show that good colza oil could be consumed to give equally as good results, photometrically, as mineral oil; but this was not universally admitted. The standard power of each size of flame, fixed for the purpose of testing the oils used in Japan, and the standard consumption to attain these powers, were as follows:—

	Power.	Rate of Consumption of 1 Gallon.
4-wick colza oil lamp	= 255 candles,	4¾ hours.
4-wick mineral "	= 270 "	5 "
3-wick colza "	= 150 "	9 "
3-wick Mineral "	= 190 "	9¼ "
2-wick colza "	= 50 "	17 "
2-wick mineral "	= 75 "	17½ "
1-wick colza "	= 10 "	86½ "
1-wick mineral "	= 19 "	92 "

Flames of these strengths were invarably maintained in the Japan lighthouses. These figures were the result of repeated, independent experiments. Allowing that only 23 per cent. more heat was evolved by mineral oil, yet the accumulation of that extra heat in a lantern during a calm tropical night was, in his opinion, sufficient to produce the effects he had stated.

The Japan Lights had been thus classified in the Paper:—1, Lights required by the treaty powers, which were principally ocean lights; 2, Lights for the Inland Sea; 3, Local lights, these being mostly harbor lights; 4, Ocean lights established by the Government. These, in his opinion, included the three divisions named by Mr. Abernethy. He had not advocated as a general principle "to put no light where the headlands were bold and well defined, or where no danger existed;" but it was one which had been adopted, after many consultations with nautical men, in reference solely to the lighting of the Inland Sea, where the circumstances were peculiar.

The Paper was necessarily of a general character, because it described a system of lighthouses and not any one in particular; but as many details of construction had been given as were deemed to be of interest. He had consulted all available authorities regarding the nature of the structures best calculated to resist earthquakes; and there seemed to be a general approval of solidity, weight, and strength, as opposed to lightness and flexibility. He accordingly adopted that principle. A lighthouse was a simple erection, and he had given in the Paper the form of each, the thickness of the walls, the sizes of the stones, and the manner in which they were arranged. The batter of the walls was in every case considerably greater than would have been thought necessary in this country.

Many violent earthquakes had occurred since the lighthouses had been erected. But on account of the inconveniences occasioned by the unsteadiness of the upper part of the aseismatic arrangement, as designed by Messrs. Stevenson, it was found necessary to secure it, and so prevent its acting. From a desire to give the design as full a trial as possible, he had repeatedly given instructions to lightkeepers at different stations to keep the tables free to act, and to report to him the result. In every instance their reports showed that the movements caused by the operation of trimming the lamps, or of performing the various other duties connected with the light—and in an apparatus having twenty-eight separate burners these were frequent—seriously deranged the flames, and prevented the machinery in revolving lights working smoothly. Under these circumstances, it became, in his opinion, imperative to prevent the tables acting. The opinion of the Messrs. Stevenson, that the tables might easily be made less sensitive without rendering them incapable of motion, was precisely the problem still to be worked out. The degree of sensitiveness to be attained was one which, while unaffected by ordinary disturbances, would afford a free motion in earthquakes. Probably to attain this might present some difficulty. An earthquake had recently displaced the glass cylinders of the twenty-one reflector lamps at Tsurugisaki lighthouse. These merely stood on their bases, and were not supported in any way. This was the only damage done at the time in the lighthouse. The earthquake though apparently not so severe as some previously experienced, had a peculiar motion. It turned the upper six or seven courses of the stone work of one of the chimneys of the keeper's house—a column of ashlar masonry about 2 feet by 3 feet, and 10 feet high—half round, and left it in a diagonal position to the lower part, without other fracture or displacement. Mr. Mallet, in his "History of the Neapolitan Earthquake of 1857," and Mr. Lloyd, both mentioned that they had observed similar twisting movements. In close proximity to Tsurugisaki there were three dioptrical lights, viz., Noshima, Kannonsaki, and Jokashima, where the earthquake had been as severely felt. In these, the large glass cylinders for the single flames were secured both at the top and at the bottom, but no derangement whatever had occurred. So far as the experience—which was not very extensive, however in Japan—went, dioptric apparatus was a little liable to derangement from earthquakes as catoptric. Mr. David Stevenson, in his Paper read before the Royal Scottish Society of Arts, said that any sudden lateral motion of the earth on which a building rests, must be transmitted through the rigid and unyielding material of the structure to the summit, where the violence of the shock would be aggravated. Having regard to the vibratory character of the movement in an earthquake, the motion being as much backward as forward; and also to the fact that no building material was absolutely rigid, or unyielding, it was clear that a shock would gradually lose in intensity as it left the foundation and approached the summit of a structure. As a matter of fact, earthquakes, which had been sufficiently severe to frighten the lightkeepers and their families out of their dwellings, had not been felt at the summits of the higher lighthouse towers in Japan. This was of great importance in the construction of buildings in earthquake countries. Recent destructive earthquakes in Japan had invariably indicated a vertical motion only; and the destruction to erections had occurred on the sharp downward movement which always followed the upheaval. Messrs. Stevenson's aseismatic tables did not provide for such a movement.

(To be Continued).

An ice machine in Dallas, Texas, just finished, produces ice cakes thirty feet long and six feet wide, weighing from 10,000 to 12,000 pounds each. They are formed by freezing fine rain or spray. When the freezing is done the bottom and sides of the cake are thawed loose from the inclined plane, and the cake slides out upon a platform where it is cut into pieces six feet square. Four cakes a day are frozen. The works cost $30,000.

Paris is awakening to the necessity of more attention to sanitary science, and the Society of Public Medicine and Professional Hygiene, lately formed, is under the immediate direction and patronage of the most eminent men in all sorts of positions. The society is divided into six sections, which will study respectively all that relates to the influence of climate on health, epidemics, including police inspection and international hygiene, private hygiene, public hygiene, professional hygiene, and statistics.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

Hadley, Mass., has voted $5,000 towards the new bridge to cross the Connecticut River, where the former one was blown away.

The Reading R. R., Company has constructed a trestle work over the Schuylkill river west of Reading, Pa., where their bridge was burnt during the railroad strike.

RAILROADS.

The people of Elgin, Ill., are confident in the belief that they will have a railroad from some point on the Mississippi within a year.

The Pennsylvania railroad has purchased a telephone, and connection was made on the 27th, ult, between the Jersey City office and Philadelphia.

The expense of the projected "pony" railroad from Bath, N. Y., to Hornellsville is estimated at $6,600 a mile, or $138,600 for the entire distance.

The operating expenses of the Baltimore and Ohio railroad are about $9,500,000 a year. About three-fourths of the operating expenses are paid for labor.

John Kendall has been employed as baggage master on the Old Colony railroad, Boston, twenty-two years, during which time it is calculated that he has travelled 974,400 miles.

The town of Mazeppa, Minn., has issued its bonds for the Midland railroad. The railroad survey is several miles up the Zumbro Valley, and the engineers are pushing on as rapidly as possible.

The Waterloo (Iowa) *Courier* says: "Only seven miles of railroad have been built in this State during the first six months of the present year, and yet the cost of railroad building was never as low as now."

Michigan has now 3,346 miles of railroad in operation, the shortest road in the State being the Paw Paw, four miles long, but now being lengthened, and the longest the Lake Shore and Michigan Southern, 403 miles long.

The engineers are surveying on the route and securing the right of way for the MiamiValley (Ohio) Narrow Gauge railway. They have reached Midway, going west. The first eight miles west of Mt. Sterling, the right of way has been secured free of charge.

Col. Tomline, a great Lincolnshire (England) landowner, is the sole proprietor of a railroad 14½ miles long. It has cost $1,250,000. He runs the business himself. The line is made in the most solid manner, and the accommodation for officials is exceptionally commodious.

The City Council of Quincy (Ill.) has decided to issue the $250,00 in bonds, ordered by the Supreme Court, in aid of the Quincy & Missouri railroad, in installments as the work on the road progresses. For the grading, bridging and tieing the first fifteen miles west of Kirksville, Mo., $75,000 will be issued.

The proposed extension of the St. Croix and Penobscot railroad to some point on the European and North American railroad, was put before the City Council at Calais. Me., on the 30th ult. An order was passed appointing Monday, August 13, as the day for the citizens to vote. The sum of money required from the city is $90,000 on completion of the road.

The Southern Minnesota railway is to be extended into Martin county this season. The company have let the job of grading the entire line from Winnebago City to Fairmount, to Messrs. Olson & Anderson, who have the contract for grading from Blue Earth City to the junction of the Martin county road.

The first section of the Nubian railway has been opened for traffic, and about 6,000 men are busily employed upon the second section. At Koye, higher up, a bridge is to be built across the Nile. This railway has not been pledged to the creditors of Egypt, but belongs to the Government of Soudan, the surplus revenues of which are being applied to its construction.

The Des Moines and Chariton road will not be commenced until next year. Notices have been issued for an election to see whether the towns will vote a tax in favor of the St, Joe, Osceola and Des Moines narrow-gauge project. The Des Moines and Minnesota narrow-gauge is a fixed fact from St. Paul to St. Joe. The contract for the last section of the Maple Valley roads calls for its completion October 1.

One of the latest Yankee ideas is a Turkish bath on wheels. It is a car that can run behind the sleeping-coaches of an express train. It has a drawing room, a Russian and plunge bath, shampooing rooms, and all the other accommodations of a Turkish bath-house. The temperature of the rooms varies from 80° to 160° and the compartments are lighted from the roof with blue glass. Travellers can bathe as well as eat, drink and sleep on the rail. Such a car can be switched off on a side track in any town or village and remain a day or two for the accommodation of the residents.

GAS AND WATER-WORKS.

Dixon, Ill., is considering the question of erecting water works.

The gas works in Greenville, Mich., have been improved at an expense of about $20,000.

Wingham, Ont., desirous of having water works, will submit a by-law to raise $9,500 therefor.

The new hoisting apparatus of the Portland, Oregon, water company will supply one million gallons of water per day.

The Department of Public Works of New York city received over $8,000 during July for water furnished to shipping.

It is reported that a petroleum gas works company will be established at Westboro, Mass., with a capital of $10,000.

The receipts for water rates in Detroit (Mich.) for July aggregated $44,192.28, of which $830,38 was for percentage.

The city of Cincinnati is laying an extension of two miles of twenty inch, and one mile of twenty-six inch water pipe.

The City Council of Jacksonville, Ills., has ordered the removal of gasoline lamps and the substitution of gas therefor.

Workmen commenced last week laying the pipes for the East Mulbery extension of the water works, at Bloomington, Ill.

We are informed that the city of Little Rock, Ark., has advertised for proposals, to be opened on the 26th inst. for the construction of water works.

The City Council of Dayton, Ohio, gives notice through its President, of its decision to improve several of the streets in that city, by lighting with gas.

Inventors are hard at work on electric lights, and the *Scientific American* says that undoubtedly electricity will soon supercede all other artificial substances for illumination.

The Lawrence, Mass., water board proposes to supply the city water to the various mills for $60 per million gallons. The corporations consume about 30 000,000 gallons annually.

In the assesment roll of personal property in San Francisco, the Spring Valley Co. heads the list, being assessed $7,000,000, and the San Fransisco Gas Light Company comes next with $6,000,000.

At a meeting of the Board of Trustees of Lake, Ills., on the 4th inst., the application of Mr. Irus Coy, for an extension of the time within which labor on the new gas works is to be commenced, was granted.

Drullard & Hayes of Buffalo, N. Y., have recently been awarded a contract for three miles of cast iron water mains for Port Huron, Mich. Competition for the work is stated to have been exceedingly sharp.

The Union Pipe Works, of Louisville, Ky., have been awarded the contract for about six miles of pipe for Des Moines, Iowa, to complete an extension to the water supply recently ordered by the Council of that city.

No steps have, as yet, been taken by the Council of Muncie, Ind., towards supplying that city with gas, although the citizens at an election, held a considerable time since, voted, by a large majority, in favor of the improvement.

Dennis Long & Co., of Louisville, Ky., have closed a contract with the McGowan Pump Co. of Cincinnati, to furnish six hundred tons of cast iron pipe for the new water works at Urbana, Ohio which the latter firm are to construct.

In the Lewiston, Maine, City Council, recently, a resolve appropriating 500,000 dollars to complete the contract with the Franklin Company and secure pure water, passed both branches to be engrossed, without an opposing vote.

The bids for furnishing and laying the pipe for the new water works at La Crosse, Wis., were opened on the 1st inst. We are informed the contract for laying the same has been awarded to McRitchie & Nichol, of Milwaukee, and that R. D. Wood & Co. of Philadelphia will furnish the pipe.

The Aurora (Ohio) Gas Company are, during the present summer, making extensive additions to their Works. They are putting in a new and much larger receiver for gas, and they are also largely extending their gas mains preparatory to lighting the streets both in the First and Third Wards.

The Anamosa (Iowa) *Eureka* says: "We are glad to learn that Mr. T. N. Boutelle, engineer of our water works during their construction, has secured a like position in the building of the water works at Burlington. Mr. Boutelle is a first-class man in every respect and made hosts of friends during his stay in Anamosa."

From the Nashville (Tenn.) *American*, we learn that a contract has been awarded by that city, for the 36 inch mains required in the extension of the water-works system, to the Nashville Pipe Works, the contract for pumping machinery of 10,000,000 gallons capacity each twenty-four hours being awarded to Dean Bros., of Indianapolis, for the sum of $26,000.

The McGowan Pump Co. of Cincinnati have contracted with the Keokuk Water Co. of Keokuk, Iowa, to construct water works in the latter city. The contractors are to receive $25,000 in cash and $60,000 in first mortgage bonds of the Water Co. Work will be commenced as soon as $10,000 more shall have been subscribed to the stock of the Company, whose books are now open for that purpose, to make up the cash payment.

The new gas company at Newton, Mass,, talked of for some time past promises to be in operation soon. It is proposed to start with a capital of $50,000, and introduce gas in the First, Second and Seventh Wards. The gas will be made from petroleum by Wren's method, and will be furnished to consumers at the rate of $2 per 1000 feet. Books will be immediately opened for subscriptions for stock.

The volume of water being pumped by the Chicago water works at present, averages during some days 60,000,000 gallons for the 24 hours, and sometimes runs during the day time to as high a rate as 70,000,000 gallons a day. It is stated that this great supply of water is mainly due to the fact that families try to economise on ice by letting the hydrants run to keep the water cool.

From the President's address before the British Association of Gas Managers, at their fourteenth annual meeting in London, on the 13th ult., we learn that a gas holder to contain 3,100,000 feet, to work in a brick tank—the largest in the world—has been designed by Mr. Woodall, of London. The contract for this monster holder has been entrusted to Messrs. Cutler & Son, of Millwall, the construction of the tank having been undertaken by Messrs. John Aird & Son, of London."

The largest water taker in Boston, is the Boston and Albany Railroad, which consumed last year over 36,000,000 gallons. The Boston Gas Light Company took over 31,000,000, the Standard Sugar Refinery 31,700,000, the Continental Sugar Refinery nearly 26,000,000, the Norway Iron Works 22,600,000, and the Old Colony and Newport Railroad 22,200,000. Among the hotels the Revere House took 11,600 000, the Parker House 1 ,300,000, and the Tremont House 9,100,00.

The City Council of Paris, Ill., at a meeting on the 28th ult., voted that waterworks be constructed in that city at an expense of not more than $50,000, and instructed the Mayor to appoint a waterworks committee to purchase a suitable tract of land and advertise for proposals accompanied by plans and specifications, for the construction of said works; said proposals, plans and specifications to be presented to the City Council for its approval within six weeks of the passage of the ordinance. We are informed that the proposals have not yet been advertised for. We hope to be able to publish them next week.

The Council of Clifton, Ohio, at their meeting on the 30th ult., by an unanimous vote, passed an ordinance for the introduction of gas. It is said that the work of laying the mains will be pushed with vigor and be completed within the next sixty days. The ordinance as passed, gives to the Cincinnati Gaslight and Coke Company the exclusive right to lay mains in the streets for ten years, "and thereafter so long as the said company shall supply gas to the citizens of Cincinnati, or until the said village shall be annexed to and become a part of Cincinnati." and also contains provisions for the emergencies of annexation to Cincinnati and the purchase of the gas works by that city.

In order to make a personal examination of the wood and mason work of the Chicago water works crib in Lake Michigan, the City Engineer, E. S. Chesbrough, Esq., recently donned a diver's dress, and in company of Captain Peter Falcon, slipped into the water at the crib, dropping down twenty-two feet, under the guidance of the veteran diver. They were under water about two hours and a half. This was the first time that Mr. Chesbrough played the part of the amateur diver, and the veteran Falcon says he displayed remarkable courage and endurance, following to the letter the instructions of his leader. At one time during their travels they came within a few feet of the orifice of the tunnel, when the noise of the roaring water and the current warned them back, which they did in good order.

The recent decision of the Supreme Court of California, in the case in which the city of San Francisco, and the Spring Valley Water Company of that city were parties, mentioned in our issue of the 28th ult, according to the Oakland (Cal.) *Weekly Transcript* will be far reaching in its influences, applying equally to all such corporations in that State, among other things it being held that San Francisco could not be made to pay for any water at all, because rates had never been fixed in the mode pointed out by law. The general law of 1858, relative to water companies, which is still authority in determining the privileges of such companies, provides that all corporations shall furnish water for *family uses*, without distinction of person and upon proper demand, and shall furnish water in case of fire, or *other great necessity* free of charge. The rates are to be determined by Commissioners, two chosen by the city, two by the company, and by them a fifth in case of disagreement. If they cannot agree on the fifth man, the Sheriff must name him. The rates so fixed shall continue one year. The only charge allowable is for family uses; for manufacturing purposes, steam, etc. Reliance must be had on the honesty of the customers, for the bill cannot be collected at law. What the city

uses for its jails, hospitals and almhouse must be paid for; it has the right free, to take what is wanted for use upon the streets, for extinguishing fires, and for parks. Such is the final decision in a large series of cases, in which the City of San Francisco and the Spring Valley Water Company have been parties. The only hope of the watermen is the possibility of a rehearing and a reversal of the judgment. Under such circumstances, it is obvious that water companies must have their rates fixed immediately, or be at the mercy of whoever would cheat them, and until rates have been so established, neither the Spring Valley nor any other Company can force the collection of its bills, or have the right to shut off water from delinquents.

MINING.

The exportation of American ingot copper to England is gradually increasing.

The bullion product for June is the largest of any month this year. The twenty-one leading mines in California, Nevada and Utah have turned out $4,121,800.

A rich vein of silver ore has been discovered five miles northwest of the town of Montague, Miss. Good judges say the ore contains 65 per cent. of silver with enough gold to pay all expenses.

The oil production of Western Pennsylvania for June was about 35,000 barrels daily average, and the daily shipment about 40,000 barrels. This shows a decrease in stock at the wells of 270,000 barrels.

At Marshalltown, Iowa, a contract has been let to bore 480 feet into the earth for the purpose of discovering whether there is coal in that city that might be developed and mined in paying quantities.

The Sutro tunnel, intended as an improved outlet for the Comstock mines in Nevada, has penetrated about three miles and a half, has cost nearly $3,000,000, and will be extended half a mile further. It was commenced eight years ago.

The Moss Bank coal company, at Danville, Ill., have struck a second vein of coal, five feet and three inches in thickness, at a distance of 118 feet below the surface, which heretofore was supposed by the miners to have no existence in that vicinity.

A French mining engineer, Sineolis, says that the silver mines of Colorado, and of northwestern Texas give undoubted evidence of great wealth. The ores are true silver ores, and the mines are identical with those of Mexico, of which they are a continuation.

The Colorado coal mines yielded in 1876 nearly 300,000 tons of coal, worth about $750,000 at the banks. This amount is likely to be increased with each succeeding year, as the use of coal is becoming much more general for domestic, mining, milling and reducing purposes in that region.

An Eastern Exchange says: "The gold excitement in the White Mountain region about Milan is at a high pitch, and so many prospectors have rushed in that the Grand Trunk Railway has established a station at the point of discovery, about a dozen miles from Gorham, which proves that gold-seeking fools are as plenty in New Hampshire as elsewhere.

The steamers which ply the Yellowstone river at a good stage of water, can run up to the coal and put out a plank to a bed where thousands of tons lie uncovered and perfectly available. Boats returning empty from the upper waters can take on two or three hundred tons in a few hours, and by utilizing this deposit, there may be made a large saving to the Government with little labor and at a trifling expense.

The *Engineering and Mining Journal* presents figures giving the results of mining in the last twenty years. The writer puts the investments in all mines and mills now in operation at $360,00,000; investments in labor, $314,000,000; personal assets, $25,000,000; total investments, $709,000,000. Return in bullion, $1,850,000,000; created value of mines and mills, $350,000,000; total, $2,200,000,000. Profit for twenty-seven years, $1,491,000,000, representing an income of $50,000,000 per annum on an investment of $709,000,000.

CONTRACTORS.

The United States Government is to build a dyke 830 feet long just above Bath, near Albany, N. Y.

The Akron, Ohio, Sewer Pipe Association is filling an order for 3,200 feet of 30-inch sewer pipe, 36 inches in length.

Messrs. Robertson & Co., of Grand Rapids, have the contract for building a new Sheriff's residence and jail at Ithaca, Gratiot county, Mich.

The U. S. Government began work at the mouth of the Chippewa River, in Wisconsin, on the 1st ult. About $10,000 will be expended in jetties and dam work this season.

Mr. Thomas, contractor for the new city hall at Ottawa, Ont., has accepted the award of the arbitrators, who give him $1,650 for extras, while he put in a claim for $11,000.

P. H. McCormick, of Columbus, Ind., and Y. W. Funting and W. R. McPherson, of Indianapolis, the architects and contractors of the new court house at Ann Arbor, Mich, began work on the 31st. ult.

Messrs. Haugh & Co., of Indianapoilis, Ind., have the contract for the entire iron work for the new State capitol building at DesMoines, Iowa. The truss is 95 feet span, of the Fink pattern, and weighs 20,000 lbs. The work to be finished under the contract of Messrs. Haugh & Co., will amount to about $35,000, and will require a year or more to finish.

The workmen engaged on the dome of the new Illinois State House, at Springfield, are making good progress. They are now at work on the lantern, and expect to complete the entire outside work of the dome by the middle of next month.

The time for receiving tenders for the construction of works for the Welland canal enlargement expired on the 3d inst. There were upwards of one hundred and fifty tenders, a great many of which were from American contractors. The Toronto (Ont.) *Mail*, of the 4th inst., says: "Nothing definite on the subject of awarding the contract will be known, probably, before the return of the Premier from the East."

The total expenditures on the new Capitol at Des Moines, Iowa, up to the 1st of July were $1,168,621.31. The law by which the building was authorized provides that "the cost thereof shall not exceed the sum of one million five hundred thousand dollars." Thus there is but $331.879 which may yet be lawfully expended, and still the great structure is but a little more than half done.

We learn from the Quebec *Chronicle* of the 30th ult., that the extensive harbor improvements of that port, which have so long and anxiously been looked forward to by the citizens of Quebec, are in a fair way of being commenced at once. Messrs. Moore & Wright, the contractors for the submarine and dredging portions of the work have just had constructed a powerful dipper dredge which was launched on the 28th ult., and as soon as some necessary machinery is received from Montreal will commence work upon their contract.

MISCELLANEOUS.

The authorities of Hamburg, Germany, think cast-iron makes the best and most durable pavement.

Portland, Maine, is suffering from the nuisance of bad sewerage, and is agitating measures of relief.

An extensiye deposit of peat, said to contain 60,000 cords, has been discovered on the Syracuse, Geneva and Corning railroad, near Beaver Dam, N. Y.

The corporators of the proposed Cape Cod ship canal, with the Committee on Harbors, went over the route lately from Cohasset Narrows to Sandwich, Mass., seven miles, and were pleased with the manifest feasibility of the work.

Pittsburgh has already a debt of about $15,000,000 and has not yet payed the bonded interest which she defaulted last April. Come to add five millions more to her indebtedness, and life will indeed be a burden to the tax-payers of that city.

The surveying party who are running the boundary line between Pennsylvania and New York reached Susquehanna county, in the latter State, last week. The greater number of milestones set up by the parties who ran the original line in 1787 are still in existence.

The scheme for connecting France and England by means of a tunnel has been abandoned and now a bridge is talked of to effect the purpose. A French engineer is the suggestor of a bridge, and he thinks it possible. The proposed bridge would be 21 miles long.

Twelve weeks was the time spent by Pittsburgh mechanics in constructing the Eads Jetty Company's steam dredge, of iron, weighing five hundred tons. It is 180 feet long, thirty-two feet beam and ten feet depth of hold, and called the most complete and perfect dredge ever constructed.

A method of burning petroleum under steam boilers has been successful in Italy. It consists simply in pouring it over a thin layer of asbestos, which, being incombustible, serves to retain the oil and provide a large wick. Sheets of paper placed beneath the furnace were not injured by the intense heat.

Attleboro, Mass., jewelers are shipping goods to Germany, Canada, Mexico, South America and Great Britain. The manufacturers have no idea who their foreign customers are, as the business is all done through exporting merchants, who make application for samples, which are sent out to the trade and returned to the manufacturers with orders.

By the new rule allowing large boats on the Champlain canal to draw four extra inches of water and small boats two inches, the tonnage of the former has been increased from ten to twenty tons, and the latter from five to eight tons. By thus increasing the capacity of tonnage of the boats of the canal, a corresponding increase in tolls is confidently expected.

Colonel Sir Herbert Bruce Sandford, the British Commissioner of the Centennial Exhibition, has just issued the first volume of his report. In regard to American architects and civil engineers, they are, the report says, possessed of sufficient science and skill to accomplish any work they may be called upon to undertake.

Last year the Prince of Wales laid the foundation of the new Glasgow Post Office, and now the bill of costs has been published—$44,000. The expenses seem to have been almost entirely for decorations, stands, platforms, triumphal arches. Eating and drinking items do not amount to $100.

Gen. Wm. Sooy Smith, of Chicago, and the eminent English engineer Job Bently are engaged examining a plan for a tunnel under the Detroit river. Engineer Bently is in the employ of a corporation of English capitalists whose business is the construction of great public improvements in all parts of the world. They have also had a meeting with W. K. Muir, of the Canadian Southern, and F. Broughton, of the Great Western.

The great Dismal Swamp Canal of Virginia and North Carolina, which had been ordered sold August 9th, it now appears is not to be sold until after Congress meets. The Government is interested to the extent of $1,500,000 in this canal, and an agent of the Treasury Department appeared at a meeting of the stockholders, held in Norfolk, July 26, and requested that the sale be posponed until such time as will give Cougress full opportunity to consider the interests of the Government. The meeting accordingly ordered the postponement of the sale.

The Iowa City *Republican* reports that a singular phenomenon has been observed by persons living along the Cedar river, The waters of the stream, usually very clear, are now and have been for several days, a dark, clear green; so green that all who look at the river are surprised at the singular appearance. It is said that on striking the water sharply with a fish pole, it sparkles with a bright lustre, somewhat like the phosphorescent light in the wake of a ship. Those who have examined it are of the opinion that the remarkable change in color is due to vegetable matter in solution. It will probably be investigated by some scientific gentlemen.

Active preparations are going on for the commencement of the long-projected work of draining the Zuyder Zee. A dam nearly twenty-five miles long is to be carried across the gulf, and upon this pumping-machines of 10,000 horse-power are to be placed, capable of discharging 6,500,000 cubic meters of water daily from the enclosed sea. It is estimated that the work will occupy sixteen years, and that it will cost 335,000,000 francs. The scheme if comp leted will form one of the greatest engineering feats of the world. It will change fishermen to farmers, and redeem the long lost acres from the floods, while the cities that have for centuries been buried may come to light also.

Regarding the recent action of the City Council of Cedar Rapids, Iowa, in paying one-half the cost of constructing a sewer on one of the streets in that city, the Cedar Rapids *Weekly Times* remarks: "We are of the opinion that it is establishing a bad precedent, a precedent which cannot be followed without doing great injustice to a large class of citizens, if made the rule in future enterprises of this character. We believe sewers for the benefit of private property should be built the same as sidewalks,—at the expense of the property owners. Sewerage in this and other thickly settled localties is now, or soon will be, an absolute necessity, but be this necessity ever so imperative there seems to be manifest unfairness im making citizens of remote parts of the city pay for their construction, and unless there is some way provided for making improvements of this character on a more equitable basis than that on which the sewer on Iowa avenue has been ordered, our city will be burdened with a heavy sewerage debt and our citizens will have just cause to complain of unfairness, if not injustice, in the use of public funds."

We gather from a recent number of the Winnipeg *Standard* some information in relation to the improvements now going on, or in contemplation, of the Red River of the North, the Assiniboine, and the Saskatchewan. The appropriation of $10,000 by the Congress of the United States will be applied during the present season to a topographical survey of Goose Rapids, with a view of building a lock and dam at that point, and to a reconnoisance of the river from Grand Forks to Pembina, thus completing the survey of 1873. The lock proposed by Major F. U. Farquhar, U. S. Engineer, in his report made in March 1874, would be 50 by 150 feet, having a lift of six feet, and with the attendant dam is estimated to cost $175,000. Little expenditure is required for the improvement of the river elsewhere. It is predicted that the Canadian Minister of Public Works will undertake, as soon as the high water subsides, a similar topographical survey from the international frontier to Lake Winnepeg, with a view to the improvement of navigation and the utilization of water-power. In such case it is to be hoped that the principal tributary, the Assiniboine, will not be omitted from a reconnoissance. The chief obstruction to its navigation consists of rapids within ten miles from its junction with the Red River at Fort Garry; immediate measures should be taken to construct a lock and dam similar to the proposed structure at Goose Rapids. The completion of these, and some improvements at the mouth of the Saskatchewan, will open up over three thousand miles of navigable waters, in the British Possessions which can ultimately be connected by the Minnesota River with the waters of the Mississippi and the Gulf of Mexico thus affording the passage of a steamer from New Orleans *via* St. Paul and Fort Garry to Edmonton and Rocky Mountain House—a distance of 5,000 miles.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,
Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 202.*)

These are the quantities as given by one authority, but from a comparison with the amounts actually used during a period of ten years on thirty-nine roads, having very various amounts of travel upon them and being repaired with all kinds of road metal, it would seem that the foregoing figures are very ample.

The exact relation between the quantity of road material that is necessary to keep a road in repairs, and the amount of travel over it, is still a matter of intelligent observation and discussion. The quantity required does not seem to be proportional solely to the amount of travel, even with one and the same kind of stone used on the same road; as will appear also, when it is considered that were there no travel over the road at all, the surfacing would, nevtheless, wear out by the action of the frost, the rain, etc. As recent an article as the "Annales des P. and C," 1877, p. 226, is devoted to this subject, and does not arrive at any definite general conclusion.

REPAIRS OF MACADAMIZED AND MUCH FREQUENTED STREETS IN CITIES.

In this case, where the amount of travel in one day is often greater than that of a month or more on the town road, the system of continuous repairs ceases to be the best available, on account of the incessant throng of vehicles not giving any repaired place a chance to become solid before it is again ploughed up and scattered. Thus in the city of Paris on the Boulevards, etc., the continuous system has been abandoned and the practice now is to let the street gradually wear down three to four inches, then close half of it (divided "fore and aft") to travel, loosen it all up with picks and put on a layer three or four inches (best not to put on more than that), spread a thin layer of sand over this, sprinkle and roll heavily. It often happens that the men put too much of the sand on; in that case, the road, after it is all done, is finally well watered and the roller again passed over it a number of times. This operation causes the superfluous binding material to come to the surface in the shape of thin mud and leaves the road covering as hard and smooth as mosaic, making a most excellent driveway. It emits a sonorous, ringing sound on being driven over and remains clean and without mud throughout the heaviest rain-storms. The rolling of the streets in Paris, is done by a company owning a large number of steam rollers; in paying them for work done, the city was obliged to go back to first principles for a measure of such work, it being found impossible to estimate correctly by the square measure of surface rolled to such and such a degree of hardness. The measure adopted is that of weight multiplied into the distance it has been moved, or "feet pounds" as we should say. It has been found from many years experience that to roll one cubic meter of macadam requires 4–5 "Kilometer-tonnes," and this is true whether the layer of macadam be three and one-quarter or ten inches thick. Expressed in our measures this is 11,020–13775 feet tons @ 2,000 @=2.09–2.61 mile tons per cubic yard of macadam.

The advocates of the steam road-roller claim, that by means of that machine, they are enabled to make a road that will wear out evenly and uniformly for 4 or 5 inches, so that the operation of patching need never be resorted to. The steam road-roller can also be used for "picking" up a road, for which purpose the roller is armed with sharp spikes, and is then driven over the surface to be "picked" up.

PAVEMENTS AND TRACKWAYS.

No essay on roads would be complete without some mention of these two species of road surface, though the use of the former is confined principally to streets, and that of the latter is out of date.

Pavements are either of stone, wood, iron, various concretes, asphalt, and may be of still other substances.

Stone Pavements.—The modern sizes of paving stones may be seen from the following cases. The Boston size is $4\frac{1}{2}'' \times 3\frac{1}{2}'' \times 7''$ deep; New York Belgian, $6\text{–}8'' \times 5\text{–}6'' \times 6\text{–}7''$ deep; new Broadway pavement, also called Guidet pavement, $3\frac{1}{2}\text{–}4\frac{1}{2}'' \times 10\text{–}14'' \times 7\frac{1}{2}\text{–}8\frac{1}{2}''$ deep. This last is laid with the long sides of the stones across the street; and, as far as the author's judgment goes, is the best size for stone pavement there is. The Boston size is too small, and allows of no bond between the separate paving stones. Further, the weakest part of each stone being its edge, it follows that the more edges there are in a given surface of pavement, the speedier will it wear out, each stone becoming rounded and slippery. It is only the excellent workmanship and great care displayed in setting these stones in Boston that prevents these facts from being at once apparent to all. When it is added that in setting pavements, the natural soil, except it be sand or fine gravel, is in all cases to be excavated 12–19 inches, and then filled up 5–12 inches, according to the solidity of the subsoil, with *clean*, coarse sand or fine, *clean* gravel, and the paving stone set in this and well rammed down with hand rammers, about as much is said on this topic as can be said without going into long details.

From four and one-half to six cubic feet of sand are required for every square yard of paving. In setting two different pavements, the same written rules may be exactly followed in either case, yet one be much better than the other, so much depends here upon good, careful, consciencious workmanship.

Wooden Pavements.—There are so many kinds of these, that it would be out of place to enumerate and describe them here. Their advantages are, less wear on tires and horses, less noise and smooth traction; a disadvantage, is their slipperiness in the winter. There seems to be a sort of notion that wood pavements and coal tar must go hand in hand; but there certainly is no necessity for this. Coal tar is applied as a preservative to the wood; but it must be acknowledged that many better ones are known and indeed are used, to the utter exclusion of coal tar, in all cases where it is desired to preserve wood, except in this of wood pavements. No wood should be used in paving that has not been first subjected to some approved method of preservation, or impregnation, as it is frequently called. The best manner of setting the same is still a mooted point, which it would be presumptuous at present to decide.

A valuable contribution to the subject of wooden pavements, is the report of the Commission appointed by the city of Boston to consider this subject, in 1872, city document, No. 100, 1873. The Commission come to the conclusion, that the best way to preserve the wood that is put down, is by the method called Burnettizing, after its inventor, Sir H. Burnett, of England, in 1838. It consists of treating the wood to be preserved with chloride of zinc. The Commissioners wisely add: "Your Commisioners are of the opinion that if the city adopts *any* method of preserving blocks to be used for pavements, some additional security should be had that the treatment of the wood shall be thorough and complete." As regards the construction of the pavement, the Commissioners recommend spruce blocks (for this section of the country), lay stress on the necessity of a solid, uniformly constituted, and rolled gravel foundation, and then say: "The rows or blocks should be set square across the street, and should be about 4 inches thick at top, with spaces of about one-half inch between the rows. This may be done with blocks of uniform thickness set apart, or with tapering blocks half an inch thicker at bottom than at top. The latter arrangement is the more costly, but it is believed by some that it will stand better, by reason of its covering the whole surface of the foundation. Longer trial is necessary to settle this point beyond dispute. Blocks of only a short chamfer at the top leave the interspace too narrow, as the blocks wear down." The Commission named consisted of "two chemists, two practical mechanics, and one civil engineer."

Cast-iron pavements are out of favor on account of their great cost, and concrete pavements are a matter of experiment as yet.

Asphalt pavements are chiefly used in Paris. They are slippery in wet weather, and produce a very disagreeable, penetrating dust in dry weather. It is necessary to prepare a bed of macadam to lay them on, and they are not used in Paris except in streets where the gas pipes are carried either in the sewers or under the sidewalks, as any leak of gas would destroy them. Their use is a matter of doubtful economy.

(*To be continued.*)

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

ARCHES;
CONSIDERED GRAPHICALLY.

(*Continued from page 201.*)

85. To deduce in this case, the value of H_t : — as before,

$$H_t \,.\, \Sigma\, E\,F\,.\,D\,E \pm 2\,E\,I\,t\,e\,c = 0. \qquad (22.)$$

From what has just been stated

$$\Sigma\, E\,F\,.\,D\,E = \Sigma\,(D\,E - \tfrac{2}{3}\,k)\,D\,E = \Sigma\, D\,E^2 - \tfrac{2}{3}\,k\,.\,\Sigma\, D\,E.$$

The first term, as before, gives $\frac{1}{12}\,k^2\,c$; since $\Sigma\, D\,E$ = area enclosed by the arch, $= \frac{4}{3}\,k\,c$, the second term is $\frac{8}{9}\,k^2\,c$. Therefore,

$$H_t \,.\, \tfrac{8}{4\,8}\,k^2\,c = 2\,E\,I\,t\,e\,c, \text{ or } H_t = \tfrac{4\,8}{4}\,.\,\frac{t\,e\,E\,I}{k^2}. \qquad (24.)$$

The bending moment at the crown will therefore be

$$M = H_t \,.\, \tfrac{1}{3}\,k = \tfrac{1\,2}{4}\,.\,\frac{t\,e\,E\,I}{k},$$

and at the springing,

$$M = H_t \,.\, \tfrac{2}{3}\,k = \tfrac{1\,2}{2}\,.\,\frac{t\,e\,E\,I}{k},$$

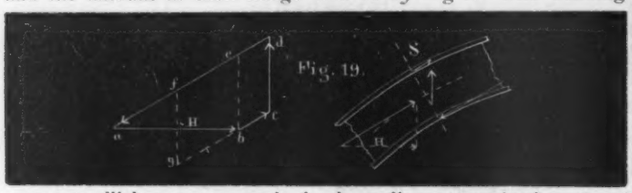
or double the former amount, but of the opposite kind. Whether the bending moment at either point is positive or negative depends upon whether H_t is tension or compression.

It may be well to notice the comparative straining effect of the same change of temperature in the two classes of arches, for ribs of the same rise. H_t is six times as great when the arch is fixed as when it is hinged at the ends, and the direct compression on the ribs will therefore vary in the same proportion. The maximum moment, at the springing, for the rib with fixed ends, is four times as great as at the crown of the rib with hinged ends and of the opposite kind, while the value of M at the two crowns is as two to one against the rib with fixed ends.

The bending moments for temperature for this second case which we have treated can also be conveniently added to the proper table, as explained for the first case.

86. The stresses induced in the web or bracing by reason of change of temperature remain to be considered. Let us suppose a fall of temperature to take place; the rib will have a tendency to come down at the crown. It is evident then, as is also shown by the sign of M, that the rib may be imagined to be loaded uniformly horizontally with a weight sufficient to produce this deflection or these values of M. This imaginary weight will be just sufficient at all points to balance the vertical component of an opposite kind which is required in combination with the value of H_t (in this case a horizontal tension), in order to give a resultant stress in the direction of the rib. For we recall that a uniform load has a parabola for its curve of equilibrium, and a load of the proper intensity on any parabolic arch will produce the value of H which is now supposed to exist. And, further, if this weight were not just sufficient to balance the above component, a remainder, of one sign or the other, would be found at the abutments, as a vertical component of the reaction there, but we know that no such vertical component exists. If a bent spring is placed with its two ends on a horizontal line, and compression or tension is applied in that line, no force at right angles is needed for equilibrium. As the uniform weight was entirely imaginary, the vertical components must be supplied by the Web, and hence we conclude that the web or bracing, of an arch affected by a change of temperature, will be strained at each point as it would be in an ordinary truss, supported or fixed at its two ends, and carrying a complete uniform load. For a fall of temperature, therefore, the shear on the web will be of the same kind as, and, for a rise of temperature, will be of the opposite kind to that produced by a load on a truss with horizontal chords.

87. These facts can be shown by the accompanying Fig. 19. If $a\,b$ represents the amount of H caused by a change of temperature, we may draw $a\,d$ and $b\,c$ parallel to the upper and lower flange at any right section S of the rib, when $a\,e$ will be the value of the direct stress at the section, being the resultant of $a\,b$ and $b\,e$, and the amount in each flange will be $a\,f = g\,b$. The bending



moment will have any magnitude, depending upon the length of the ordinate from the springing line to the point on the centre line of the arch where this section is taken. As $a\,e$ and $g\,b$ are parallel, the vertical distance $b\,e = c\,d$ between them is constant, so that $f\,d$ may be taken, for our purpose, to represent the stress in one chord and $g\,c$ that in the other due to bending moment, the resultant stresses being $a\,d$ and $b\,c$, while the shear on the web will be $c\,d$. Since the resultant stress at any section must be H, the directions of the forces, shown by the arrows, in this closed polygon are at once fixed. As the inclination of the arch changes, the value of $c\,d$ will change, being zero at the crown and a maximum at the springings. The rate of change of $c\,d$ is seen to be such as is found in a beam uniformly loaded. The arrows denote the case where H is a thrust. The bending moment will be negative, if the rib is hinged at the ends, the bottom chord will be compressed, the top chord will have a force upon it amounting to the difference between the direct thrust and the tension due to the moment, and consequently $b\,c$ will be the stress exerted by the top chord against the right side of the cross-section in the accompanying sketch.

88. Passing next to the consideration of the arch whose curve is the arc of a circle, we shall assume that the rib is of uniform section, and not, as before, of increasing breadth from the crown to the springing. We stated, it will be remembered, that a segmental arch of the latter type, if the rise did not exceed one-tenth of the span, might, without serious error, be treated as if it were parabolic. In discussing circular arches there will be so many steps similar to those we have already explained, that we shall not go into much detail on some points, but leave the reader to make the extended application as examples come up in his own practice.

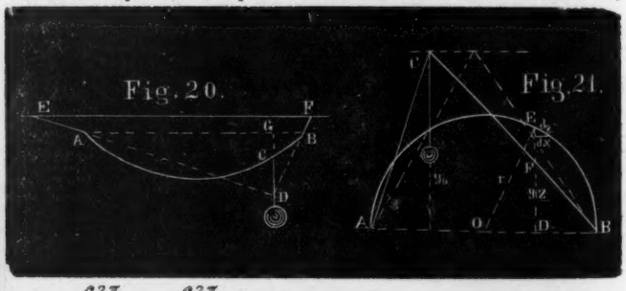
As the rib is of uniform section, it can no longer be compared to a horizontal beam, as regards its change of inclination and deflection under bending moments, and the length along the arch, instead of its projection on a horizontal line, must be used in summing up the usual quantities; that is, the sum of the changes of inclination between any two points will be made up from the change of inclination at each successive point *along the rib*. We must therefore use $d\,s$ for $d\,x$ in our integrations, where s denotes the length of an arch, and polar co-ordinates will, in the more complex cases, be used in place of rectangular ones. In spacing off the rib for equal divisions, or for summing the ordinates arithmetically, the measurements will be made along the curve, and each division will subtend the same angle at the centre of the circle.

89. The values to be obtained for y_0, for a rib of uniform section, curved to the arc of a circle, and hinged or free to turn at the ends, can be readily verified or ascertained experimentally as follows: Take a piece of moderately stiff iron wire and bend it accurately into the desired shape, A C B, Fig. 20; suspend the wire from a horizontal bar E F by means of strings fastened at A and B, and then attach a weight at any point C. It will be convenient to stretch a thread from A to B which, as the span is to be unchanged, will not interfere with the reactions. If the point E is now moved horizontally, the length of the string E A being at the same time changed, the line A B can be brought horizontal or parallel with E F, as can be readily ascertained with a scale. Then E A and F B prolonged will meet at D on C D, and D G will equal y_0. E A and F B will really intersect on the vertical through the centre of gravity of the wire and weight combined, but, if the wire is as small as is consistent with stiffness, while the weight at C is large in comparison, the centre of gravity will practically be in C D. If A B becomes slack, it shows that E and F are not sufficiently far apart. By fastening two long threads independently to E and F the lines E A and F B can be easily prolonged to an intersection.

60. If the rib with hinged ends is first taken up for discussion, the value of y^0 for a load at any point on a semicircular arch is easily obtained by a simple device. Recurring again to the usual formula, in its modified form, § 45, (9), we must satisfy the condition

$$\Sigma\, D\,E^2 = \Sigma\, D\,E\,.\,D\,F.$$

If we let D E, Fig. 21, $= z$; D F $= y$, and represent a small portion of arc by $d\,s$, this equation becomes for the entire semi-circle,



$$\int_0^{2\pi} z^2\,d\,s = \int_0^{2\pi} y\,z\,d\,s$$

If we draw a radius from any point E of the rib to the centre O, and also draw the infinitesimal triangle whose sides are $d\,s$; $d\,x$ and $d\,z$, we shall have, from similarity of triangles,

$$r : z = d\,s : d\,x, \qquad \text{or} \qquad z\,d\,s = r\,d\,x;$$

substituting this value in the above equation we get

$$r\int_0^{2c} z\,d\,x = r\int_0^{2c} y\,d\,x.$$

(*To be continued.*)

OUR RAILWAYS AND THEIR ECONOMICAL USE.

I.

As a nation, as communities, or as individuals, our progress, our social advancement, our very existence even has become so closely identified with the means and cost of transportation, that whatever affects the latter produces a corresponding effect upon the former, while the almost complete paralysis of our entire commercial and industrial interests by reason of the recent strike, illustrates how absolutely dependent these are upon an uninterrupted facility of transportation. Our railway system, vast as it is, is of such rapid and recent growth that we could not appreciate its benefits nor realize its importance to our well being, until its functions were deranged, its avenues blockaded, and the commerce of a continent brought to a sudden standstill. It is perhaps because of this wonderful rapidity of construction, and of the vast and innumerable interests and industries that have sprung therefrom, that so little is as yet understood by the general public respecting the efficient and economical management of this class of property. That such ignorance exists is, we think, shown by the striking diversity in construction of road bed and equipment, and in the still greater diversity of opinion respecting the management. Lines possessing different characteristics may well be supposed to necessitate differences in management, but why, on different lines possessed of the same general character as to grades, locations, and connections, should different views obtain as to the construction of the motive power and the consequent operation of the trains? This want of practical knowledge upon the subject of railways has been very seriously felt for many years, but more especially for the past few.

By practical knowledge we mean a thorough and complete acquaintance with the forces to be overcome, in the movement of trains, and the best and most economical generation and adaptation of power to overcome them. What railway men in this country can tell what power they are realizing from a pound of the fuel they are using? what per cent. of its actual value they are utilizing? A majority with whom the writer has conversed think it to be from 50 to 75 per ct. whereas, in fact, it is only from 3 to 5 per ct. No railway man can tell you about the friction of his cars, or in fact any of his equipment. When we find the leading officials so ignorant of the truth, we need not be surprised to find the same want of knowledge in the subordinate employees, neither can we expect an improvement without some data from which to make comparisons, and see when and what improvements are possible. Had it not been for the competition among locomotive builders, and inventors, we should not find the locomotive as far advanced to day as it is. The very first questions one would have expected to have been investigated, have hardly been noticed; detached observations have been made and occasional opinions circulated, but little has been done to make a thorough and systematic investigation of the subject under consideration, by railway companies.

In the forthcoming series of articles, on railways and their economical management we shall endeavor to point out many of the relations existing between them and the leading industries of the country and their mutual influences which now, as heretofore have been so little comprehended by the public, that opposing interests have grown up where harmony should have existed to the benefit of all concerned instead of injury as at present. We are writing for the express purpose of conveying information to the masses, and therefore shall avoid as much as possible, for their benefit, abstract professional technicalities, since, before much good can be accomplished, real economy understood, and permanent benefits introduced in our railway system, the public, the stockholders, the bondholders, and the mass of subordinate employees, as well as the managers, must be educated to a just appreciation of the bearing and importance of railways upon their interests.

It needs no argument from us to convince any one that the low prices for which transportation has been conducted for the past four years, in comparison to its actual cost, has been otherwise than beneficial to the business of the country and consequently to the people. The demand for cheap transportation has been heard throughout the land, and in response thereto competing lines of railroads have been built, to various places, largely in excess of the demands of the business of the country, so that the cry of cheap transportation has been more than fully realized by the loudest of its adherents, and as a consequence we have seen a rapid depreciation of railway property, which in turn has crippled the industries of the whole country. The volume of business did not increase, but the financial receipts decreased very rapidly, and consequently expenses were reduced, until the climax we have just experienced culminated. We are not advocating high prices for transportation, but only that all useful and needful labor shall receive a just compensation. It is time for moderation, yea, careful consideration by the radicals, on either side of this great railway question, and that of capital *versus* labor. There are just relations, and an equality of interests existing between them, which, when practiced, gives business a healthy tone, and causes it to move in its proper channels, and we must, sooner or later, recognize the fact that underlying all the vast and varied pursuits of the country, are certain principles, whether we observe them or not, which control their actions, and are just as positive in results as the natural laws which control the universe. We daily see the effects of these natural laws in the growth of vegetation, flowing water, wind, rain, falling bodies, revolution of the earth, etc.; we do not see the laws, principles or forces themselves, but only the effect produced by their action, yet we know certain laws exist.

ON THE FAILURE OF THE ASHTABULA BRIDGE.*

GEN. GOUVERNEUR K. WARREN:—I know of a circumstance that is interesting in considering the conflicting views of the engineer of the surviving locomotive and some of the passengers, as to whether the train was off the track or not, before the bridge broke. The case is as follows:

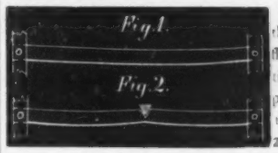
I am occupying a wooden frame building, built here about 160 years ago. In the spring of 1871, while sitting at work in a room 21 feet square, in the second story, something apparently of great weight fell upon the floor of the garret above me, shaking the house alarmingly and bringing down some of the ceiling.

The garret was stored with furniture, some of it consisting of earthen and iron ware packed in barrels. It did not belong to me, and I informed the owner of the building that if it was not removed at once, I should vacate the house. He removed the furniture, which operation I watched carefully, but could not discover that anything had fallen to produce the shock.

The matter remained a mystery to me until last spring, at which time the dangerous condition of the ceiling of the room compelled me to remove the plaster. I then found the main beam which supported the garret floor, broken short off, the ceiling being supported mainly by the garret floor.

The old style of floor beams was very different and very inferior to the present one. One large beam of oak, a foot square in section, went through the middle of the floor or ceiling, and small joists rested on this and the sides of the room. This main beam always sagged down so as to crack and otherwise deform the ceiling beneath, and some inconsiderate modern carpenter invented a way of straightening this beam by sawing it through about two-thirds from the top; then forcing it up from below by strut and wedges under the middle where the cut was, he made the beam come up to the old level at the middle part. The cut was thus opened like a wedge, into which an iron wedge was driven; the strut below was then removed. The timber being very old, this flexture at the cut ruptured many of the fibres of the wood, which thereafter had to sustain a great tension—like the bottom chord of a bridge truss, whose height was small in comparison to the span, 1 in 21, the introduced iron wedge acting as the top chord. It has been a wonder to me, how the beam stood what it did, which was probably due to the ends of the beam bracing against the sides; and it broke as short as would a piece of steel wire under a breaking strain of tension. It, as it were, snapped, and the giving way was so sudden, that the shock was precisely that of something falling.

If then, the bottom chord or a tie rod snapped, or if one after the other did, at Ashtabula, the sensation in the cars would be that of a car jumping off the track on to a beam. The engineer, a little removed from the place where the break occurred, might not feel such shock, which he could hardly have failed to do, if the shocks had been the striking of the car wheels against floor beams, which would have made a jerk upon the engine.



The following show the rectified ancient floor beam, as practiced here in Newport; Fig. 1 being as before, and Fig. 2 as after, straightening. After this is done, they hew off the smaller convexity on each side, or level up with furring pieces, and plaster it over again—as well hidden a human trap as ever was set for wild beast.

MR. EDWARD S. PHIBBRICK:—I had an assistant* at Ashtabula, sent to inspect the wreck as it was removed, from whom I have some facts which may be of interest. He states that:

1°.—The bottom lateral bracing was composed of flat bars, 2½ × ½ inches, applied in panels of 22 feet, and attached to chords by hooks in ends of ties which fitted recesses in angle blocks. The struts were railroad track bars, and were applied at points intermediate between those points where the lateral brace ties were attached. The latter had no adjustment for length.

Thus if these ties had been screwed up, the only effect would be to put the chords out of line, and make them assume a zigzag form; and all lateral forces arising from wind or trains passing, which would operate to break up the alignment of the chords would not be controlled by this lateral system—its only effect seeming to be to pull the structure into a serpentine line.

2°.—The only attachment for the transverse vertical bracing was by hooks fitting into the angle blocks, and held in place by ⅝-inch tap bolt. These ties were adjustible by turn-buckles, and were applied at intervals of 22 feet at same points as the lateral bracing, and therefore intermediate between the bottom transverse struts.

3°.—The top chords are composed each, of five lines of 6-inch I beams side by side. They were clamped or held together only by two ⅝-inch bolts, per panel.

4°.—The lugs which were cast on the angle blocks, for the purpose of holding the main braces in place, were mostly chipped off when the braces were turned on their own axes, before using the bridge, and did not fit the new position of braces. Some of these showed several inches change of position when last painted. These braces of the main trusses were clamped at their intersection, *i. e.*, where the main brace intersects the counter, by two 1-inch bolts only, not passing through, but outside as a yoke.

As to position of wreck, the first set of braces in the south truss at west end, were found nearly parallel with the face of abutment, with their upper ends *under* the north bottom chord, which bent them somewhat where falling on them. The bottom chords were nearly parallel, the south one lying near centre line of bridge, both having moved about 8 feet north, and both had moved in falling, about 8 feet east, *i. e.*, endwise, folding up their east ends against the east abutment. The first set of vertical rods in the south truss, beginning at its west end, had their top angle block slid quite down to the bottom chord, and lay spread out fan-shaped towards the abutment. The next set had the top angle block also down, but were bent to the south. The third set of rods bent over to the north, with top angle block nearly down. Others with angle blocks at top end, bent north till near east end of bridge, where they bent south again. All the rods of the north truss were bent to the north. On the top angle block of the south truss, second from its west end, the paint showed that the chord bars which abutted against this block had a bearing on one edge only, as if the bar in the first panel were sprung convex to the south, while others in same

* Discussion by the American Society of Civil Engineers.

* Mr. A. H. Howland, who has had considerable experience with various styles of iron bridge plans.

line in next panel eastward, indicated being convex to the north. All the I beams, forming the top chords, main braces and floor beams, were dragged out as soon as possible after the disaster, and irrevocably mixed. But the position of the bottom chords, vertical rods, angle blocks, etc., as given above, taken together with the evidence of the engine-men, seem to indicate these points, viz:

The failure began by the buckling or displacement of either main braces or top chords at about the second and third panel from west end of south truss. The angle blocks belonging to top chord at this point were all slid down the whole length of the rods, which passed through them, 8 in number at each block, and this could only happen *after* the braces ceased to support the angle blocks, and *before* the rods had left their vertical position to any extent. The second set of rods were bent over to the south, possibly getting started in that direction before the train began to fall. The floor must have sunk first on the south side, for that side only was loaded, and the train was piled up on the south side. The lateral reaction of its fall, from the sloping deck, would push the rest of the bridge north as it did go, even against the powerful wind. The west end of the bottom chords falling first, as the north truss leaned over, the whole hinged for an instant while falling, upon the east end, pulling the bottom chords eastward, as found.

Diligent search was made for evidence of derailment, but none found—a few wheels were broken and cracked, but nothing to show whether they were sound or unsound before the fall. They showed marks of a good deal of heat, and could have easily received all the injury they show, even more, by the fall of 70 feet and subsequent roasting. Some 40 ties were found, but no wheel marks on them.

There seems to have been sufficient elements of instability in the disjointed and poorly connected top chords and main braces to account for the disaster, even without any derailment of wheels. This floor is described to be better than that upon many other bridges which I have seen carry trains over with wheels off the rails without injury, though an increased thickness of planking would have contributed much to this one in such cases.

MR. ALFRED P. BOLLER:—As an engineering work, the Ashtabula bridge has lost much of its interest, so thoroughly have the particulars and details concerning it, been published. We all know it to have been a conglomeration of errors, and principally astounding in its longevity. Why it lasted a week after the staging was knocked out, can only be answered by reference to the doctrine of "special providences." That it lasted a dozen years, is a superb tribute to the value of iron in bridge construction, showing the torture that material will stand before the penalty is paid, that nature exacts for ignorance. Without moralizing over the design, ignorantly conceived and faultily carried out, and one that any bridge expert would have condemned after less than five minutes inspection, the lesson of the disaster is of the highest importance to the whole community.

In the first place, the most pointed lesson to be learned, is to recognize the limitation of human powers, and the necessity of men keeping within the bounds of their exact knowledge. Too many of us, in the belief that we are "engineers," feel it incumbent in our professional pride, to lay claim to all knowledge covered by the term *engineer*, and are far too ready to assume responsibility in any engineering matter brought to our attention. The public aids in keeping up the flattering fiction that an engineer must, of course, know all of engineering, and the same individual is often called upon for sage advice on subjects of the most diverse character. The modern engineer's experiences are far from being so varied as those of a generation before him, and it is now almost impossible to be an expert in more than two or three subdivisions of the profession. As knowledge increases, it necessarily requires division of labor, which must become more and more subdivided as each class accumulates new facts and experiences.

This is a law of civilized development, and being such, it surely need be no weakness for any of us, to admit that there are many things we do not know, or that others know much better. A man may have general ideas concerning a locomotive, pump or a bridge, but how absurd it is for him to undertake to design one or the other, when there are those who have given their lives to the study and practice of each specialty, and are ready at a moment's call to furnish any desired information. A knowledge of general principles, is far from being a knowledge of design, in a practical sense. The former can be learned from books, the latter the books teach only in a small part.

The time has about arrived for us to overhaul our classification whereby the term engineer would have some prefixes, recognizing the divisions of labor under which the profession is constantly developing. The result of such classification, would be that engineers would be compelled to range themselves under it, sooner or later, according to their knowledge, and the public would very quickly learn to pick out a professional advisor, for his special knowledge in the department of engineering wherein information is sought.

Then, if men wanted a locomotive built, they would go to a locomotive engineer, or to a hydraulic engineer for hydraulic works, or to a bridge engineer for their bridges, or to a locating engineer if they wanted a railroad laid out, and so on. If this principle had been recognized a dozen years ago, Mr. Stone would probably have not undertaken to design the Ashtabula bridge in iron, but would have called in the best attainable expert of the day. Mr. Whipple would have built him a good bridge, so would Mr. Linville, or Mr. Fink, men who at that day had become experts, and peculiarly so the former gentleman, who thirty years ago, was not far behind our theories of to-day. And so I read the lesson of the Ashtabula disaster: not to be actuated by a false pride to undertake to do things we do not understand, but rather exercise worldly common sense in calling to our aid those whose studies and experience have made them experts in the thing to be done.

(To be Continued).

THE JAPAN LIGHTS.*

BY RICHARD HENRY BRUNTON, M. INST. C. E.

(Concluded from page 210.)

The Author begged to acknowledge the facilities which were afforded him by the Messrs. Stevenson, before he proceeded to Japan, for obtaining a detailed and accurate knowledge of lighthouse construction. The records of their office were placed at his disposal, and they personally assisted him in every way, especially as regarded the design and construction of the optical apparatus, in which matters they were pre-eminent. He also mentioned the assistance he had received at one time from H. E. Mr. Wooyeno, Minister in England for Japan, who, almost at the outset, was the commissioner appointed by the Government to take charge of the work. By his energy and high intelligence he succeeded in extricating the work from serious difficulties in which it was involved, owing to the peculiarities of the native workmen. Unfortunately his Excellency only remained in the Lighthouse Department for a short time, by which the assistance of a willing and an able colleague was lost, just at the timewhen such services were most needed.

Mr. W. D. Cay referred, through the secretary, to the advantages of the use of gas for the lighthouses in situations occasionally inaccessible. He had recently completed the works for lighting, in this manner, the lighthouse at the seaward extremity of the New South Breakwater at Aberdeen, the tower of which has been described in the Minutes of Proceedings of the Institution. The lightkeeper was unable to pass along that breakwater during storms on account of the waves, so that it was necessary to have a constant light; and it had been so arranged that this was kept low during the day, and the full pressure was turned on at sunset by a cock placed on the shore. The gas was brought from the town of Aberdeen in a 2-inch pipe, upwards of 2½ miles long, crossing the river Dee by the Suspension Bridge in a lead pipe, and was carried along the breakwater in a wrought iron pipe sunk in a groove cut in the concrete, and covered with a pitch-pine beam. A gas holder, inclosed in a house, was provided at the shore end of the breakwater, holding a week's supply of gas: and a dry gas meter, placed on the pipe from the town, prevented the return of gas towards the town, when through any cause the pressure in the supply pipe should be less than the pressure in the holder. These arrangements had been completed, and tested and had been found to work in a satisfactory manner. The total cost, including the lighthouse which had been built of concrete in 1873, the lightroom, lanterns, gas supply works, etc., would be about £2,200.

Mr. J. J. Coleman remarked, through the secretary, that it was only within the last few years that mineral oil had been used for lighthouse purposes. Previous to 1868 the possibility of using mineral oil in lighthouses had been considered by the Trinity House, but the then existing lamps were not found suitable for its application. In the month of March of that year Captain Doty submitted to the Trinity House authorities a burner with a concentric wick, which he asserted would answer the purpose. This, however, was a crude affair; and the Deputy Master lent Captain Doty a lamp of the first order as a model. Another and more perfect burner was constructed, and sent in the course of the same year to the Trinity House. Professor Tyndall examined it, and did not advise its adoption; but, during the two ensuing years experiments were made by Mr. J. N. Douglass, M. Inst. C. E., who altered the existing Trinity House burners, so as to adapt them for burning mineral oils. A first order light so altered was used successfully at Flamborough Head in 1871. In the meantime, Captain Doty had succeeded in introducing his burner, and the use of mineral oil for light house purposes, into France; the late Emperor of the French taking considerable interest in the subject. He was also successful in interesting the commissioners of Northern Lighthouses, through their Engineers, Messrs. D. and T. Stevenson. Dr. Stevenson Macadam examined the photogenic power of mineral oil when burnt in Captain Doty's lamp, and made an exhaustive report to these gentlemen on the 31st of December, 1870. Assuming a given weight of colza oil to yield a light denoted by 1,000, Dr. Macadam stated that an equal weight of mineral oil furnished in

First order of lamp, a light equivalent to				1,184
Second "	"	"	"	1,544
Third "	"	"	"	1,734
Fourth "	"	"	"	2,040

and concluded thus:—"I am of opinion that paraffin oil consumed in Doty's lamps alike from readiness in trimming and lighting up, from steadiness of flame, and from high photogenic power, possesses decided advantages over colza oil for-lighthouse illumination." In April of the same year, Dr. Macadam reported that he had got still more favorable results with the first and second order of lamps by an alteration of the wicks. These experiments were simultaneous with practical trials of the oil at Girdleness, Pladda, and Pentland Skerries lighthouses. In December 1871 appeared a report by Professor Tyndall, who had been employed by the Trinity House to examine into the relative merits of the lamp used by the Trinity House and that introduced by Captain Doty. Dr. Tyndall's experiments lasted fifteen days, and he thus concluded an elaborate report on the matter—"With oil No. 1, which appears to be more suitable for lighthouse purposes than any other, the Doty lamp shows a small but distinct superiority. As regards this oil, the simple changes introduced by Mr. Douglass into the Trinity burner appear to be almost as effective as the more elaborate devices of a central button and an external jacket introduced by Captain Doty. But as regards the combustion of oils richer in carbon, and, therefore, more liable to produce a smoky flame, the Doty lamp possesses, within certain limits, a distinct advantage. On the whole, therefore I should pronounce the Doty lamp the more effective of the two." Mr. Douglass' alterations of the old colza burner were as follows, according to Dr. Tyndall:—Altering the tips of the wick cases, introducing a perforated disc at the centre of the flame, and modifying the form of the glass chimney, also altering the level of the oil (an expedient previously adopted by Captain Doty). The issue of this report was followed by a voluminous correspondence, extending from 1871 to 1874, between the Trinity House, the Board of Trade, the Northern commissioners, Messrs. D. and T. Stevenson, and Captain Doty, relating to certain claims on patent rights and proposals to settle the same. In reference to this report, the question of vegetable oils *versus* mineral oil was considered by Dr. Tyndall to have been settled by previous reports of Dr. Macadam, Mr. Valentine, of the Royal College of Chemistry, Mr. Douglass, and Messrs. D. and T. Stevenson. After quoting the re-

port of Mr. Douglass to the Trinity House, that with mineral oil used in a single wick-lamp an economy of 72.7 per cent., and with a four-wick burner of 60.5 per cent., had been gained, as against the results obtained by the use of colza oil, Dr. Tyndall remarked:—"This consensus of evidence leaves no doubt upon the mind that, as regards cost and illuminating power, the paraffin light really possesses the advantages claimed for it." Meanwhile the French Government had been actively at work, and by the year 1872 sixty-nine lighthouse stations in France were being supplied with paraffin oil. In 1873 M. Reynaud reported to the Foreign Office that Captain Doty had been awarded 10,000 francs by the French Government in recognition of his services; and in the same year the Duc de Broglie reported, through Lord Lyons, that two kinds of burners were giving good results, viz., the Doty and a modified form of Fresnel lamp, made by M. Henry Lepaute: and that they cost the administration the same price viz.:—

	Francs
Five meshes	60
Four "	50
Three "	40
Two "	32

In 1874 the Trinity House reported to the Board of Trade that paraffin oil was used in nineteen English lighthouses, and they recommended its introduction into twenty more, and a contract was entered into with Messrs De Mille & Co. for burners, the prices being as follows:—

	£	s.
Five wicks	10	15
Four "	8	0
Three "	6	0
Two "	4	10

In the same year, also the Board of Trade sanctioned the Northern Commissioners introducing through (Messrs. D. and T. Stevenson) the Doty burner and mineral oil into all Scotch lighthoues. As regarded the economy of mineral oil for lighthouse purposes, its cost had always been under that of colza, or other fatty oils; frequently only one-quarter, and never more than one-half the price. In foreign stations, it would appear from the Paper that it was also economical, notwithstanding the expense of packages and freight. Mr. Brunton had remarked correctly, that much care was required in the selection of the oil, and in freeing it from the volatile constituents which were always present in crude or imperfectly refined mineral oils. If a standard of 145° to 150° flash point were too low, it would be easy to manufacture an oil having a flash point even as high as 250°, which was the quality of oil supplied for the use of saloon lamps of marine steamers. There was one point which the Author seemed to think of importance, viz., the heat produced during the combustion of mineral oil, as compared with that evolved during the combustion of vegetable oils. To use the words of the late Professor Rankine: "The total heat of combustion of any compound of carbon and hydrogen is the same as the quantities of heat which the hydrogen and carbon contained in it would produce separately by their combination with oxygen, and when hydrogen and oxygen exist in the compound in proper proportion to form water, these constituents have no effect on the total heat of combustion."

The average constitution of vegetable oils was:

Carbon	76
Hydrogen	12
Oxygen	12
	100

Applying the above rules, the available carbon and hydrogen for producing heat in say 100 lbs. of the oil would be:

	lbs.
Carbon	76
Hydrogen	10½

Again, the average composition of mineral oils was:

	lbs.
Carbon	85
Hydrogen	15
	100

Now the number of British heat units produced by burning 1 lb. of hydrogen was 62,032, and by burning 1 lb. of carbon 14,500, therefore the following calculation would show the total heat of combustion of vegetable *versus* mineral oils:—

Vegetable oils.			
Carbon	76	× 14,500 =	1,102,000
Hydrogen	10½	× 62,032 =	651,336
			1,753,336
Mineral oils.			
Carbon	85	× 14,500 =	1,232,500
Hydrogen	15	× 62,032 =	930,480
			2,162,980

Thus mineral oils evolved 23 per cent. more heat in burning than vegetable oils; but, on the other hand, taking into consideration the increased light they gave, the amount of heat evolved per unit of light was actually less with mineral oils, than with vegetable oils, when the average results of various burners were taken as the basis of calcution. It appeared probable that the breakage of glass chimneys, observed by the Author, was owing to the fact that the mineral oil flame was generally more concentrated than that of a vegetable oil, thus localising the heat produced. He would suggest that if this difficulty caused too much trouble, the form of the chimney, or the construction of the burner, should be altered so as more effectually to spread the flame.

Geology of Japan.

At this meeting the President directed attention to an interesting series of 123 specimens of the Mineral Products of Japan,—a gift to the Institution from the Government of that Empire; whereupon it was

Resolved unanimously,—That the best thanks of the Institution be recorded, and be tendered to the Japanese authorities, for the interesting and valuable Collection of Geological and Mineralogical Specimens which they had offered for the acceptance of the Society.

In speaking to this Resolution, Dr. Pole desired, as one of the English engineers whom the Japanese Government had honored with their confidence, to remark upon the interest taken by the authorities in engineering works, and how actively those works were being introduced. It was a pledge of the earnestness with which this was being done, that the authorities were investigating very carefully the mineral resources of the country, as was abundantly proved by this admirable collection of specimens. A great deal of information had been acquired, which was not formerly possessed, showing that the country was exceedingly rich in mineral products. The Government had not confined their attention to small specimens for exhibition merely; for he had, within the last few days, received samples of limestone from Japan, which he had been commissioned to get analyzed, with a view to ascertain whether hydraulic lime could not be obtained, so as to save the large expense involved in the importation of Portland cement from England. The specimens presented to the Institution would no doubt prove extremely valuable. Considering the connection of English engineers with Japan, which he hoped would long continue, it would be interesting and useful to know what the products of the country were, which could not be better shown than by the specimens presented. But there was another reason for feeling grateful to the Japanese authorities—the kindness shown by them to the large staff of English engineers in that country. Many members of the Institution, and other Englishmen and Europeans, were engaged there, and all gave but one account of the behaviour of the Government to them. Formerly their lives would have been in danger, but now they were perfectly safe, and were treated with the greatest courtesy and consideration.

His Excellency Mr. Wooyeno, the Japanese Minister, expressed, through Mr. Nagasaki, his great gratification at the statement that the collection of minerals sent by his Government was valued by the Institution. He should always be glad to do anything in his power to promote the interests of so large and important a body, and to advance scientific knowledge.

A RAILROAD STUDY.

Among the social forces of the modern world the railroad holds unquestionably the first place. There is not a single occupation or interest which it has not radically affected. Agriculture, manufactures, commerce, city and country life, banking, finance, law, and even government itself, have all felt its influence. But especially has the railroad been a potent influence in providing the material organization for the diffusion of culture among the people, and thus preparing the conditions for a new step in the social progress of the world.

On the 1st of January, 1832, it was reported that there were nineteen railroads either completed or in progress of construction in the United States, and that their aggregate length was nearly 1400 miles. Though Congress afforded no material aid to this new era of internal improvements—the land-grant system not having been yet invented—yet this same year it exempted from duty the iron imported for railways and inclined planes, and actually used for their construction. In 1840 it has been estimated that our yearly average of railroad construction was about 500 miles. In 1850 this average had increased to 1500. In 1860 it was nearly 10,000, and in 1871 it was stated that enterprises requiring an expenditure of $300,000,000, and involving the construction of 20,000 miles of railroad, were in actual process of accomplishment. In 1872 the aggregate capital of the railroads of the United States, which were estimated to embrace one-half of the railroads of the civilized world, was stated to amount to the sum of $3,159,423,057, their gross revenue being $473,241,055.

With such a rapid growth of the railroad era, it was naturally to be expected that every thing connected with it has not been conducted in the most orderly manner possible. People learning by experience are apt to make mistakes, and when an entire nation is simultaneously passing through the same educational process of culture, it can not be expected to reach perfection at the first attempt. There was no precedent by which the railroad should be governed, nor which the people could consult for guidance in dealing with it. The turnpike and canal were as incompetent precedents as the games of children would be for the serious business of their after-life. And as the railroad has had to create its own engineers, competent to deal with the new problems of construction it has introduced, so has it had to originate its own financial measures: and it was inevitable that the criticism of a larger experience might justly find fault with the mistakes of both. Were the problem to-day presented to the country, with the knowledge that we have upon railroad matters, to furnish anew a system of railroad transportation as competent for our industrial needs as that we now have, there is no doubt an arrangement would be made very different from any now existing. The existing system was not constructed to meet the needs of the present course of trade, but for totally different necessities. At the same time, but for the advent of the railroad, the trade which now finds itself hampered for want of facilities would never have existed. None of the trunk-lines, which are the only reliance for bringing to the Atlantic coast the grain crop of the West, were designed for this work. At the period of their construction there was no settled West, and no grain crop to transport. They were built to connect other points, and to supply other needs. The facts in the construction of the New York Central will show this readily. This line between Albany and Buffalo, consisted originally of various smaller roads, built for local needs, and consolidated in 1853. The consolidation agreement was entered into by the following roads: the Albany & Schenectady; the Schenectady & Troy; the Utica & Schenectady; the Syracuse & Utica; the Rochester & Syracuse; the Buffalo & Lockport; the Mohawk valley; the Syracuse & Utica, direct; the Buffalo & Rochester; the Rochester, Lockport & Niagara Falls. The simple statement of the names of these roads shows how local and fragmentary was the early growth of the railway. There was no conception then of the trunk lines. The very knowledge of the topography of the West, as the term is understood to-day was as vague, almost, as at the time of the settlement of America, when the charters of the colonies were described as extending from the Atlantic to the South Sea, or, as with Connecticut, to the Pacific Ocean.

The material record of the railway in the United States, as we have seen, is no mean achievment. It has met and overcome obstacles of distance and construction in a way which justifies the belief that it will be equal to any future emergency which can arise. Hampered by the want of ready money in the com-

munity it came proposing to aid, it has devised and successfully practised financial methods as new as its methods of transportation. Towns and counties have been induced to bond themselves for its aid. The capitalists of the Old World have been seduced into taking their bonds. Stockholders—frequently there were none—and those who supplied the funds on construction bonds have seen the property pass to other hands, from whom fresh levies had been made with mortages as security. The attainment of our railroad system has probably been as financially disastrous to the class of investors who bore the brunt of the first cost, as the settlement of the country itself was to the orignal supporters of the colonies settled along the coast from Massachusetts to Georgia, and especially the proprietary colonies. The incompetence of the methods of one era to meet the exigencies of the next is nowhere seen more plainly than in the development of finance. Though it has been claimed that "it is safe to say that this forgotten element in the account (the mere amounts of money actually paid into construction, and since wiped out of existence by insolvency or loss of interest)would constitute more than a set-off for the largest amount of watered stock ever alleged to have been issued," yet it is hardly to be expected that the debtor and creditor accounts of the railroad with the public can be kept in this way with entire satisfaction to the community. For the community, with the railroad itself, has gone through a process of education, though possibly in a different direction.

The remedy with the railroad, as with the feudal baron, lies in the culture of the people, in their practical comprehension of their position, and their organization for attaining a better because a juster, system. In educating the people to this conception the railroad itself has been the most potent factor. It has been the agent teaching order, punctuality, and business promptness to the whole country. The old farm methods have all been superseded. The slow and leisurely way of putting off until to-morrow which formally prevailed no longer will suffice, or is still found only on the outskirts, where the whistle of the engine is not heard, or the regular arrival of the train does not compel the shipper of his produce to be ready at a specified hour. Local prices no longer exist, but are all regulated by reference to those of the cities, quoted in the daily papers. Agriculture has been infused with a spirit of business, and the farmer, instead of looking to his farm to furnish its own supply of fertilizers and for the chief consumption of his crop, now looks to the distant market for both purposes. It is the same with the small interior towns. The freight of the railroad enters as a factor in every exchange performed all over the country, and its rise and decrease is a subject of importance to every one. The railroad, therefore, should not complain if the people, having been educated to the conception of the absolute importance of accuracy and method in their business relations with the railroad, should demand of the railroad the exercise of the same qualities in its relations with them.

When it is remembered that the important Congressional committee upon transportation to the sea-board, in their report, recommend the establishment of a national Bureau of Commerce, it will be seen that a new era is approaching in our railroad history—the era of order and method, in which both the railroad and the public by their acts will show that they mutually understand and respect each other.—*Edward Howland in Harper's Monthly for September.*

HARPER'S MONTHLY for September is an unusually interesting number, and we cannot conceive any more profitable investment of thirty-five cents than in its purchase. We give elsewhere its table of Contents, and also have taken the liberty to extract largely from a most valuable article on the Railroad problem, which we recommend to be read in full by every person who is interested in railroads and their management.

PUBLICATIONS RECEIVED.

Transactions of the American Society of Civil Engineers, for June and July, 1877. New York.

Transactions of the Society of Engineers, for 1875 and 1876. London, England.

Transactions of the Institution of Civil Engineers London, England: Hull on a Deep Boring for Coal at Scarle, Lincolnshire. Robinson on the Transmission of Power to Distances.

Laws of the State of Illinois for 1877. Springfield, Ill., 1877.

Annual Reports of the City Officers of the City of Paterson, N. J., for the year ending March 20, 1877.

Harper's New Monthly Magazine for September contains the following: The Lading of a Ship—Ernest Ingersoll; The Domestic and Artistic Life of Titian—Helen S. Conant; General Stark and the Battle of Bennington—H. W. Herrick; Snow Storm on Mt. Shasta—John Muir; Ma'mselle, a Story—Miss E. A. Mooney; Tom Moore in America—Benson J. Lossing; Large Schools *versus* Small—Anna C. Brackett; A Late Wild Rose—a Poem; Prince Edward Island—S. G. W. Benjamin; Ali, a Poem—Harriet Prescott Spofford; Shadows, a Story—Mrs. E. T. Corbett; A Group of Classical Schools—Horace E. Scudder; The Pastor's Reverie—Rev. Washington Gladden; Popular Exposition of some Scientific Experiments, Part VI. Concerning Thermometers—Dr. John W. Draper; Erema, or My Father's Sin—R. D. Blackmore; American Workmen from a European Point of View—Leonard W Bacon; A Visit to a Country House, and what came of it, a story—Annie T. Howells; Waifs from Motley's Pen—Park Benjamin, Jr.; A Railroad Study—Edward Howland; Editor's Easy Chair; Editor's Literary Record; Editor's Scientific Record; Editor's Historical Record; Editor's Drawer.

Manchester Science Lectures for the People, Eighth Series, 1876-7. Three Lectures by Professor Roscoe, F. R. S., on "What the Earth is Composed of." Three Lectures by J. Norman Lockyer, F.R.S., on "The Earth's Place in Nature." Three Lectures by Professor W. C. Williamson, F.R.S., on "Life on the Earth.' Price twenty-five cents.; illustrated.

Science Lectures at South Kensington: "Photography," two Lectures—Capt. Abney, R.E., F.R.S.; "Light," two Lectures—Prof. Stokes, F.R.S.; "Metallurgical Processes," two Lectures—Prof. A. W. Williamson, F.R.S., University College, London; "Physiological Apparatus," two Lectures—Prof. Burdon Sanderson, M.D., LL.D., F.R.S., and Dr. Lauder Brunton, F.R.S.; "Electrometers," two Lectures—James Bottomley, F.R.S.E., Demonstrator of Natural Philosophy in the University of Glasgow; "Kinematic Models" two Lectures—Prof. Kennedy, C.E., University College, London; "Sound and Music," two Lectures—Dr. W. H. Stone; Price twenty cents each. "The Steam Engine," two Lectures—F. J. Bramwell, C.E., F.R.S.; "Field Geology," two Lectures—Prof. Geikie, F.R.S., Director of the Geological Survey of Scotland. Price twenty-five cents each. London and New York, Mc Millan & Co., 1877. Chicago, Jansen McClurg & Co.

The titles of these little hand-books explain the nature of the series; the names of the authors are a sufficient guarantee of their genuine value as popular expositions of several very important subjects. To most of the readers of this journal "Outlines of Field Geology" cannot fail to be of interest, as it comes directly within the province of every engineer who has any field practice at all.

THE BAD ODORS OF DRINKING WATER.

The citizens of Rochester, N. Y., were much inclined to congratulate themselves—and certainly on excellent grounds—when they had brought water thirty miles from the crystal depths of Hemlock Lake for the use of the city. But last year, to the astonishment and disgust of the people, their water became so offensive as to give rise to grave apprehensions respecting its effect upon public health. In October it suddenly began to emit a peculiar fish-like odor, which continued until the following December. It was a very natural suggestion that this odor must be due to the presence of fish, which had somehow found their way from the lake into the main pipes, and from thence into the smaller service pipes, where their progress had been arrested, and they were undergoing slow decomposition. It is well known to those familiar with the experience of other large cities, that similar annoyances are by no means uncommon elsewhere. Regarding this we learn that "not long after the introduction of the Croton water into New York, and of the Cochituate water into Boston, the fish-like odor prevailed for some time to a most disagreeable extent. While this odor is of most frequent occurrence, others of a very much different character are occasionally reported. Last year the Bradlee Basin, which supplies a part of the water for Boston, became affected with an odor described as closely resembling cucumbers. None of the other ponds in the neighborhood were similarly affected. About the same time the water of Springfield, Mass., exhaled the odor of green corn. In 1874 the water of Cherbourg, France, became intolerable from an odor undistinguishable from that of a pig-sty. This same odor occurred last summer in Horn Pond, from which East Boston and Charlestown are in part supplied. The odor of decaying wood is not uncommon, especially in early summer."—*From Professor S. A. Latimore's Report, in Popular Science Monthly for August.*

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

Sterling, Ill., voted by a large majority, on the 11th inst., in favor of borrowing $40,000 to build the proposed Mulberry street bridge in that city.

The contract for building the piers and abutments for a new bridge across the Kankakee River, at Momence, Ill., has been awarded by the C. D. & V. R. R. Co., to A. Werner of Joliet, Ill. Wells French & Co., of Chicago, will build the superstructure, the same being a low truss, in seven spans of 55 feet each.

The following bids were received on the 6th inst. for an iron draw in the Chelsea, Mass., Bridge: Leighton Bridge and Iron Works Co., Rochester, N. Y., $11,800; Keystone Bridge Company, Philadelphia, $12,000; Passaic Rolling Mills, Passaic N. J., $12,294; Delaware Bridge Company, New York, $15,810. 78. The contract was awarded to the Leighton Bridge and Iron Works Co.

The Milwaukee *Sentinel* of the 9th instant says: "The town of Milwaukee is about to tbuild a new bridge across the Milwaukee River, on the Washington road, about two miles and a half beyond the Shooting Park. The structure will rest upon a wooden centre pier, the eastern abutment is to be of stone, the spans, two in number, are each to be 75 ft. long, and the roadway is to be 18 ft. in the clear."

Messrs. Clarke, Reeves & Co., of Philadelphia, are actively engaged in constructing the bridges they have under contract for the Q. M. O. & O. Ry., in Canada, concerning which the Montreal *Herald and Daily Commercial Gazette* of the 10th inst., in an article descriptive of the above named road, says: "The bridges are all from the Phœnixville Works, and those already erected at the Back River, St. Rose, Belle Riviere, Lachute, etc., fully sustain the reputation of Messrs. Clarke, Reeves & Co."

The Columbia Bridge Works, of Dayton, Ohio, were awarded eleven contracts, for bridges, on the 7th inst., four of them to be constructed in Indiana, and the others in Ohio. They will range in length from seventy-five to two hundred and twenty-five feet. Work was begun on one of these across Wolf creek, two miles from Dayton, on the 8th inst. It is to be of iron, a single span one hundred and seventy-five feet long. The rush of work will make necessary the employment of an increased force of men.

The Prescott, (Arizona,) *Weekly Miner* remarks: "As the subject has been canvassed to some extent as to when the S. P. R. R. Company were going to build a bridge which would span the Colorado, we concluded that the attempt is about to be made from the fact that they have a steam pile-driver purchased to be used in driving piles, as shown by the following from the Sacramento *Record-Union* of the 11th of July: 'There has just been completed at the railroad shops a steam pile-driver, to be used in driving the piles for the Southern Pacific R. R., bridge across the Colorado river at Fort Yuma. It will be forwarded to its destination in a few days.'"

A meeting of the Pittsburgh Coal Exchange was held in that city on the 7th inst., for the purpose of conferring with the Government engineers relative to the location of the new bridge over the Ohio river at Rochester, for the use of the Pittsburgh & Lake Erie R. R. Company. In addition to the members of the Exchange there were present, Gen. Simpson and Col. Merrill, Government engineers, several steamboat pilots, and Charles Davis, Esq., engineer of the Pittsburgh & Lake Shore R. R. Company. The site of the bridge as proposed by the railway company is a point six hundred feet below the little run at Phillipsburg, but the prevailing opinion among pilots and others was that the bridge should be erected some three hundred and fifty feet above the point named. After considerable discussion a vote was taken, and the upper location approved unanimously. It was also voted that the location of the shore pier on the Phillipsburg side of the river should be placed at a point one hundred and fifty feet from the high bank, and that the width of the channel span should be five hundred feet. The proposed bridge will be similar in style to that of the Pan Handle bridge over the Monongahela river. Engineer Davis said the proposed change in the location would entail an additional expense of $30,000 on the company in constructing approaches. Col. Schoonmaker, the chairman of the meeting, said the difference in the cost between a 450 foot span and one of 500 would be $60,000. No one was authorized to state what the directors of the company would do in regard to the suggestions voted upon. The Government Engineers expressed no opinions whatever, but left the same evening for Cincinnati, where they will prepare their report.

GAS AND WATER-WORKS.

The common council of Elgin, Ills., have decided to extend the water mains in that city.

Gas (and good gas too) costs in London only $1.10 per 1 000 feet, and in Berlin only $1.25 per 1,000.

The village of New Edinburgh, Ont., is anxious to have the benefit of the water works of Ottawa City,

but cannot come to terms as to the amount to be paid for the privilege.

A generous ice company at New London, Connecticut, is begging that city to place suitable water tanks in the various streets and let the company keep them full of ice free of charge.

Bids were opened in Baltimore, on the 6th inst., for the five millions of five per cent. city water loan. There were sixty-three bids, amounting to $4,202,000, from par to 103 per cent.

The Mayor and aldermen of Montreal, inspected the new city water-works at the Inland Cut, on which about $300,000 have been laid out, on the 8th inst., and found all satisfactory.

The Boston gaslight company have the largest single-lift gasometer in the world—203 feet in diameter, 40 feet high and with a capacity of 1,250,000 cubic feet. But it has not been used since it was built, a year and a half ago.

Mr. Hanchett, the President of the water works company of Niles, Mich., has negotiated the bonds of the company in New York, and operations will be commenced upon the new works as soon as the necessary tools arrive.

The State Centre (Iowa) *Enterprise* says: "The council, Wednesday evening, the 1st inst., added $500 to the amount of corporation bonds already authorized to be issued, making the total amount to $2,500. These bonds are to be issued as needed in the building of the water works."

The authorities of the town of Walkerton, Ont., last week advertised for proposals to be opened on the 14th inst., for a system of water-works, for fire protection, to be driven by water power; tenders being conditional on the passing of a by-law, to raise money for that purpose, which will be voted upon to-day.

The Boston water board on the 10th inst., awarded the contract for building dam No. 3 of the Sudbury river water-works to J. E. Fuller and V. Nash (Fuller & Nash of Worcester), whose bid was $69,040. There were twenty-two bidders in all, and Michael Kiernan & Co., were the lowest bidders, but withdrew.

The City Council of Peoria, Ills., at their meeting on the 11th inst., adopted an ordinance requiring that hereafter boxes used in the water-works, of that city, for the purpose of turning on or shutting off water shall be the iron box known as Jarecki's patent shut-off box, made by Jarecki, Hay & Co., Erie, Pa.

At a meeting of the water works committee, of the city council of Pittsburgh, Pa., on the 7th inst., the sub-committee reported in favor of dividing the contract for laying the rising mains to the new reservoir but the committee decided to let the contract as a whole. Messrs. Miller & McCann, of Steubenville, were the lowest bidders. They asked $13,374.00, but their bond was not satisfactory and the contract was awarded to A. G. Shade & Co., the next lowest bidders, at 13,473.00. The highest bidder was Wm. Paul of Allegheny, who asked $15,141.20 for the entire work.

While the Emperor and Empress of Brazil were on a short visit to Glasgow on Thursday last, says *The Engineer* of July 13, his Imperial Majesty inspected the works of Messrs. Thomas Edington & Sons, of the Phœnix Foundry, when he witnessed the process of casting water pipes. This firm, along with three other Glasgow houses, those of Messrs. D. Y. Stewart & Co., Robert Laidlaw & Sons, and Robert M'Laren & Co., are engaged on a contract of 80,000 tons of pipes for the water works of Rio de Janeiro. Of the contract 15,000 tons have already been shipped, and the agreement requires to be completed in the course of the year 1879.

The New Haven (Conn.) *Palladium* says: "The water supply question does not appear to be nearer solution at Hartford. The majority of the council seems to be in favor of the West Hartford system as against the Connecticut river plan. Water meters for the city would cost about $100,000, and those who think paying for water by measure would result in saving enough to give the city a full supply through the dry months believe that the expense would be better than to spend $70,000 for a new reservoir that would need to be enlarged in ten years. The trouble seems to be, however, that no really reliable meter can be found, and besides, extravagant users are in a body against the plan."

The Hamilton, Ont., correspondence of the Toronto *Globe* of the 8th inst., says: "The new filtering basin connected with the city water works is nearly completed, and then the city will have a supply of water at all seasons of the year, which can have no limit, except in the pumping capacity of the engines and the size and number of the service pipes. No city in the world will then be able to boast with truth of a better supply or a supply of better water than the ambitious city of Hamilton. Another main, however, from the reservoir into the city will be necessary to make the water-works all that could be desired, and it is probable that this will be furnished within a year or two, or as soon as the city funds will warrant it."

At a special meeting of the city council of Moline, Ill., on the 10th inst., the special committee on "further fire protection" submitted a final report recommending that an ordinance be drawn authorizing the laying down of water pipes for fire purposes in accordance with the plans heretofore submitted; provided that the cost of said improvement shall not exceed the sum of $6,000. The estimated cost, (without any competive bids) is as follows:

2,200 feet 8 inch pipe, 49 tons @ 31	$4,426 00
3,600 " 6 " " 59 " "	1,829 00
9 hydrants @ 40	360 00
15 T's or connections @ 15 each	225 00
Digging trenches and laying pipes	2,160 00
Total cost	$6,000 00

The last item estimated allows $38.26 per foot, which the committee think a very high estimate. The report of the committee was unanimously accepted and it was decided to raise the money for the purpose by a general tax.

From a lengthy editorial in the Brooklyn (N. Y.) *Union-Argus* of a recent date, we learn that the charges of fraud, both in the granting and conduct of, what has been known for several years in that city, as "the Reservoir Contract," have been finally set at rest by the report of the Committee of Referees—composed of citizens of high repute,—appointed by Judge Neilson before whom the contractors for the building of the reservoir, Messrs. Kingsley & Keeney, brought suit against the city, for the sum of $178,000, claimed as the balance due them on their work. The investigation which has been searching and patient, and extending over a period of a year, fully exonerates the Board of city works from the charges of collusion and corruption made against them, and finds that the contract was granted and made to the lowest competitors, according to law; that the work has been carried out in the spirit of the contract, and that the plaintiffs, Messrs. Kingsley & Keeney, the contractors, are entitled to the sum claimed, though they hold that under the present action but $107,000 can be recovered, as that is all that remains of the $1,400,000 authorized to be expended by the city of Brooklyn in the construction of a storage reservoir. It is considered probable that the plaintiffs, though they have established the integrity of their position, their conduct, their contract and their work, since they are awarded $71,000 less than they claimed, which the referees admit is their proper due, will either appeal or seek under some other action to recover the difference between the amount claimed and that allowed them.

RAILROADS.

Work will soon be resumed on the D. M. A. & M. railroad at Des Moines, Iowa.

A narrow-gauge railroad has been located from Des Moines, Iowa, to Webster City.

The management of the New Brunswick and Canada railroad has decided to have a narrow-gauge.

Five steam street cars are being built for a Brooklyn, N. Y., company at an average cost of $3,100 per car.

There are two counties in the State of Pennsylvania which have not a rod of railroad within their limits—Forest and Greene.

The prospects for the building of the Cayuga railroad extension from Cayuga to Port Byron, N. Y., are now looking very favorable.

The Argentine Republic now possesses 1284 miles of railway, of which as nearly as possible one-half, or 664 miles has been constructed by the State.

The Alliance & Wheeling railroad has been chartered to run between the towns mentioned, in Ohio and West Virginia. The route will be surveyed immediately.

Chas. Crooke, C. E., of Flatbush, L. I., is the Chief Engineer of the Midwout, Amersfort and Coney Island R. R. company, a newly projected road on Long Island.

The Cleveland & Ohio River R. R. company have filed a certificate of incorporation. Capital stock $500,000, in shares of $50. The proposed line will run from Cleveland to Gallipolis.

An Iowa Exchange says:—"With grangers to say how much railroad companies shall receive, and employes to say how much they shall pay out, the owners of railroads ought to be singularly free from care."

The Lake Shore road has an automatic railway in operation at Ashtabula, Ohio, for unloading ore from vessels, etc. The ore is hoisted in buckets by steam, and the cars are then run down an inclined plane and dumped.

The Monmouth (Ill.) *Atlas* says:—"The subscriptions to the Burlington, Monmouth & Illinois River narrow-gauge, between Monmouth and Fairview, aggregate $50,000, leaving $49 000 to be raised. The towns which are behind have till August 24th to raise their quotas."

The Waterloo (Ont.) *Advertiser* learns that the people of Roxton Falls are uniting to demand from the South Eastern Railway company the completion of the R. D. & A. branch of their railway from Sutton to Acton. In case they do not comply, they intend applying to the Local Government in the matter.

The Cincinnati *Enquirer* says:—"The next strike will be among the stockholders of the various railroads. They have been working at reduced rates for a long time. The earnings of the roads, which should have been dividends, have been taken from the roads by the outside freight lines, which are the blood-suckers to the railroad proper."

The Memphis *Avalanche* has interviewed General N. Reneau, a North Mississippian, just from Mexico. He has a big railway scheme on hand, connecting Mexico with the United States, for which the Mexican Government has made large grants. General Reneau proposes to sell this grant to the United States Government for $25,000,000. Guess the United States can get along without this grant.

The Denver and Rio Grande railroad, the pioneer narrow-gauge is steadly extending its line south toward Santa Fe and the Mexican border. It has lately, by wonderful engineering, crossed the Sangre de Christo Pass, a spur of the Rocky Mountains, at an elevation of 9,380 feet, the highest point reached by a locomotive on this continent, and will probably rest for the season at Indian river, a few miles this side of Fort Garland.

A railroad company was organized at Fort Scott, Kansas, on the 2d inst., called the St. Louis, Ft. Scott & Colorado Railroad company. Thirteen directors were chosen, six of whom are from St. Louis, and seven from Kansas. Fort Scott and Humboldt are named as points on the proposed route. Energetic efforts will be at once inaugurated toward building the road, work to commence soon. The road is already graded between Ft. Scott and Humboldt.

A railroad is proposed from San Matteo, Putnam County, Fla., to Orange Lake, Marion County, 28 miles. It will be a narrow-gauge road with wooden rails, operated by steam. Construction will be commenced during the ensuing winter, the surveys having already been made. This road will give a much needed outlet to the great orange growing region about Orange Springs where 250,000 oranges rotted on the trees last year for want of transportation.

The Red River and Manitoba Railroad company is a new organization, with a capital stock of $500,000, designed to build a road from Breckenridge, Minn., the terminus of the main line of the St. Paul and Pacific company, to a point on Red river near St. Vincent. The immediate object of the company, and upon which work is to be commenced at once, is the construction of the cut-off from Breckenridge to Barnes, a point twelve miles south of Glyndon, at which latter point the St. Vincent extension crosses the Northern Pacific Railroad, a distance of thirty-three and a half miles.

The directors of the Bedford, Brownstown and Madison (Ind.) Narrow-gauge Railroad company have let the contract for building the road to Messrs. Irwin & Hanna, of Indianapolis, and Mr. Sullivan, of Madison. The contractors are to receive $30,000 per mile for the first six miles of road constructed and equipped on the Madison division, and $10,000 for each subsequent mile so finished. Samuel McElfatrick, chief engineer, began the survey for the permanent location at Madison on the 1st inst.

Suit was instituted on the 3rd inst., in the Chancery Court at Covington, Ky., by E. Cummings, against the Trustees of the Cincinnati Southern Railroad, for over a hundred thousand dollars. Mr. Cummings was the contractor for sections 95, 96, 97, 98, 99, 101, 102, 104, 105, 106, 107, 108, of Division E. The petition alleges the whole of the labor done and material furnished by the plaintiff to have amounted to $642,472.86 and credits the defendant with payments amounting to $543,010.71, leaving $99,462.15 as the balance due and sued for with several months' interest. Plaintiff complains that the consulting or principal engineer failed and refused to make true and correct estimates and classifications of the work, and, on the contrary, made incorrect, false and fraudulent estimates and classifications.

The Atchison, Topeka and Santa Fe Railroad company is making arrangements for a survey for the extension of the road into New Mexico. The President of the company is reported as saying: "The railroad company will survey every proposed route where reliable parties will guarantee one-half the expenses of said survey. There are at present several proposed routes: First, from Pueblo via Ute Pass, in South Fork; second, by the Valley of the Upper Arkansas to Lake City; third, also by way of the Upper Kansas and Canon City to the head of the Gunnison river; fourth, from La Junta via Trinidad, and via Costilla Pass to the Rio Grande; fifth, also from La Junta via Trinidad and Cimarron to Albuquerque, and sixth, from La Junta via the Dry Cimarron to Albuquerque." It is thought that the road will be constructed via Trinidad, because of the easy grades, favorable climate and comparatively well settled country, which will furnish local business at once.

MINING.

At Puerto Llano, in Ciudad, Real, Spain, a rich seam of coal, ten feet thick, has been discovered.

During the present month the Society of Scientific Mining engineers of Spain will celebrate at Madrid the hundreth anniversary of the formation of the organization.

The coal-miners of Knox county, Tenn., recently visited Nashville to confer with the lessee of the State Penitentiary and protest against the introduction of convict labor in the mines.

The rediscoverery at Canquenes, Chili, of the once famous gold mine, "Los Cristales," has created somewhat of a sensation. This mine, whose yield is supposed to have been almost fabulous in the old colonial

times, has been lost for forty years. Having been abandoned at the breaking out of the revolution, it filled with water, and then a landslide removed all traces of it.

The coal companies at Streator, Ill., are now mining and shipping 125 car-loads of coal per day, which is regarded as a good trade for this time of the year.

Gold-bearing quartz from Reading's gold mines, seven miles southeast of Talladega, Ala., is about to be shipped to Omaha, Neb. If the ore proves as rich as expected $100 000 will be invested in the mine.

Gold-bearing quartz which it is asserted assays from "$3 to $200 per ton" is being taken from Hussey's hill, near Rondout, Ulster county N. Y. and a stock company will be organized to prosecute mining operations.

The only locality in the United States, in which there is any prospect of success in mining for tin, is in Los Angeles county, California. On the Temescal ranche it is said to occur in considerable quantities, in ferruporphyritic rock.

President Barrios, of Guatemala, has sent General Buntray to the United States to secure the services of a competent geologist to pronounce upon some gold deposits recently discovered in the Republic. The samples taken from the mines, show great richness and purity of deposit, so it is stated.

Ohio's coal field, says an eminent geologist, is a district 100 miles square, including the counties of Athens, Perry and Hocking. In fifty years it will probably equal Staffordshire or any district in the world. The district has twenty-two feet of solid coal in five seams. The great vein is in places twelve feet thick, and nowhere less than six feet. Mingled among the coal beds are inexhaustable beds of iron. The thickest is five feet deep at the out-crop; the thinnest, in places, sinks to six inches. But the thickness of neither seam is quite persistent; there are "waves" from time to time, which narrow the seam. The coal, on the contrary, may be said to run from hill to hill with perfect uniformity. Limestone is also present in any desired quantity.

CONTRACTORS.

Messrs. Smith & Null, of Cedar Rapids, Iowa, have the contract for the construction of a new school building in that city, the cost of which will be $10,575.

The Vulcan Iron Works Co., of this city, have completed an engine of 75 horse power, for a large tannery on the west side, which has been built under the superintendence of Fred. Wilcox Clarke, C. E. and architect.

Grand Tower, in Jackson county—on the Mississippi river— has been selected by the Southern Illinois Penitentiary Commissioners for the location of the new State Penitentiary. The Governor, State Auditor and Attorney General have yet to signify their approval of the Commissioners' selection.

William Scott & Co., architects, of Detroit, have, under instructions from the Board of Supervisors of Chippewa county, Mich., contracted for the building of the court-house at Sault Ste. Marie, with James and Edward Garrett, builders, also of Detroit, they being the lowest bidders for the work. Operations are to be commenced at once, and an effort will be made to enclose the building before the winter sets in.

The County Supervisors of Lake County, Ill., have adopted the plan of H. C. Koch & Co., of Milwaukee, for a new County Court House, to be located in Waukegan. The structure is to be built of brick with stone basement and trimmings, and will cost between $30,000 and $40,000, and is to be commenced in the early fall. Proposals will be advertised for as soon as the plans and specifications are completed.

The Commissioners of Hamilton County, Tennesee, have accepted the plans of Mr. A. C. Bruce, Architect, of Knoxville, for the new Court House to be built at Chattanooga. There were eleven competitors from different parts of the West. From the Chattanooga *Dispatch*, of the 10th inst., we learn that Mr. Bruce will, in about twenty days, have his plans ready for bids on the various classes of work and material required in the erection of the building. He calculates to have the building completed in about fifteen months.

The Commission to locate the Eastern Illinois Insane Asylum has decided to accept the proposition made by the citizens of Kankakee, and have selected a site containing 251 acres of land, lying upon the south side of Kankakee river and immediately east of the Illinois Central railroad. The price to be paid for the property is $14,000. Proposals will be advertised for, as soon as plans and specifications are adopted and the Kankakee *Times* says: "It is probable that the contract will be awarded by September 15 and work on excavations and foundation commenced this fall."

MISCELLANEOUS.

Sandusky, Ohio, is to have a street railroad.

Jacksonville, Florida, has torn up her street railway.

New Haven, Conn., is going to connect its public schools with telegraph wires.

China has her first telegraph line in operation. It is only six miles long, but the most significant point is that the natives have not torn it down.

An odd kind of export is a small section of brick wall, just sent by New Haven, Conn., builders to Constantinople, as a sample, in response to an order.

The Boston city council, after considerable discussion, has passed the order borrowing $3,712,000 to build the gigantic sewer to Moon Island, in the lower harbor.

The Paving Department of Boston, Mass., has about 1000 laborers at work upon the streets, nearly 200 more than last year at this time. The wages are $1.75 per day.

Much attention is being paid to sewerage improvements in Paterson, N. J., and surveys are now going on under the charge of John T. Hilton, C. E., for extensions to the present system, which it is stated will take two years to complete.

A bird seller, of Montreal, has notified the Health Department of that city that he intends to commence an action against the city for the value of 300 birds—canaries, etc.—that have died, as he alleges, from the bad drainage from the building, for which he holds the city responsible.

Constanstinople has a circumference of about thirteen miles. Its harbor, "Golden Horn," is a long, capacious inlet of the Bosphorus, running along the northeast side of the city, with sufficient depth for the largest vessels, and capable of receiving 1,200 sail vessels at one time,

Very little is known of a remarkable natural curiosity in Southern Illinois in the shape of a natural bridge. It is near Pomona, on the Cairo & St. Louis R. R., and is a wonderful freak of nature. It is of pure sandstone, 100 feet in length on top, and 76 feet from one abutment to the other. It is 60 feet high, and 8 feet broad on top. The average thickness is 9 feet, and a team is said to have crossed it in perfect safety.

Captain Brown, of the United States Engineer Corps, in charge of the inspection of the jetties at the mouth of the Mississippi river, has sent to the War Department, at Washington, a report which states that Eads' jetty system is a substantial success. All that impedes the passage of a ship drawing twenty feet of water through the entire length of the jetty is a little strip 140 feet in length. Through the west of the channel there is a depth of twenty feet of water.

The American Association of Amalgamated Iron and Steel Workers, met at Columbus, O., on the 7th inst. Delegates were present from New York, Philadelphia, Pittsburgh, Buffalo and the great iron regions of the country. The association has been in existence in the United states about one year. Its membership at present numbers between 25,000 and 30,000. The object of the association is to embrace in one union all those directly engaged in the manufacture of steel and iron.

A canal is proposed from Leesburg, on Lake Griffin, Sumter Co., Fla., to Panasofkaee Lake on the Withlockoochee River, which has its outlet in the Gulf of Mexico. It will be but 16 miles long and will connect the waters of the east and west coast of Florida so that steamers can cross from the unparalleled rich gulf hummock with the produce of that fertile region, and connect with steamers to New York. This short canal will open up 3000 square miles of the most fertile semi-tropical country in the world, which now has no outlet.

The work on the Saginaw river improvement at Carrollton Bar, Mich., is progressing. This season the revetment has been extended some 500 feet and the unexpended balance of the $11,000 appropriation, available this year, will be devoted to dredging the channel. The work is of the most substantial character, and thus far has met the expectations of its projectors, as well as removing what for years has been an eyesore and hindrance to the navigation of the Saginaw river.

A correspondent of the Lafayette (Ind.) *Daily Journal*, advocating a more complete and efficient sewerage system in that city, says:—"From a list of towns and cities of population varying from 7,800 to 52,000, the average mortality per thousand before the construction of sanitary works (*i. e.*, sewerage and water supply), was from 23.4 to 35.2. After the completion of the works, this was reduced from 12 to 32 per cent. In typhoid fever there was a reduction of from 35 to 75 per cent., and in phthisis, or pulmonary consumption, from 11 to 49 per cent.

The citizens of Omaha, are becoming seriously alarmed at the inroads which the Missouri river, in its washout, is making upon the bank on the Nebraska side of the river, and a large meeting of the citizens has been held to consider the question. The Omaha *Bee* says that immediate steps should be taken to make a permanent levee for the protection of the "bottom" lands, as the river has changed its course and that whole section is in imminent danger of being swept away. Upon these lands are situated some of the principal manufacturing establishments of the city, among them being the smelting works, and the Union Pacific shops.

On Thursday, the 9th inst, the Illinois and Michigan Canal Commissioners, accompanied by a number of citizens of Peoria and Pekin, Ill., inspected the work at the Copperas Creek dam, on the Illinois river. About five miles above the dam the party were shown the point at which excavation will be commenced to open a channel from the Illinois river to the head of Spring Lake, which must be done before the dam can be completed, as it will close the outlet at the foot of the lake. The Commssioners give notice for bids for this work, which is to cost, as estimated by Mr. Jenne, chief engineer, some $6,000. At the dam the gentleman inspected all the improvements, including the dykes built on both sides of the river, the preparation of cribs and other material for the dam, and last, but not least, the lock itself, all of which elicited much admiration. The lock will pass fifteen canal boats at once, and the dam, which will be six feet high, will give five feet of water above low water mark at Pekin, four and a half feet at Peoria, and four feet at Henry. When the distance from these points to the dam and the height of the dam, only six feet, is considered, it seems marvelous that such results are accomplished. The expenditure to date is $270,340—total estimated cost $416,000, including $80,000 from the general Government.

For some time what is known as the "east channel," of the Mississippi river, opposite La Crosse, Wis., has been gradually filling up by the deposits brought down by the river, and the Board of Trade of that city, in consequence of the commercial interests of La Crosse, imperilled thereby, recently employed an engineer, Mr. G. P. Bradish, to make soundings and estimates as to its progress and the measures to be taken to keep the channel open. We learn from the La Crosse *Republican and Leader* that at the meeting of the Board on the 7th inst., Mr. Bradish read his report and exhibited elaborate maps and charts showing the change in the channel since the soundings begun. The report was very complete and traced the action of the river up to the latter part of July, demonstrating beyond any doubt the fact of the complete reversal of its course. From his soundings he was able to give the amount of change in the slough as an increase of eleven inches in depth, per month for the past three months, while the east channel had shoaled to about the same extent in average cross section. The change in the east channel could not be realized from this statement, however, as the location of the channel was now such that navigation is extremely difficult even if there was more water. The report was accepted and placed on file. On the 8th inst., the members of the Board and the business men of the city generally, made an investigation, the result of which was only to confirm more fully the universal belief that the best channel is now on the west side of Barron's island and that the one on the eastern side of the island is changing and filling up so rapidly that it must soon leave La Crosse without means of approach from above. For the past three months the channel at the head of the island on the eastern side has been filling up at the rate of over one hundred feet per month, so that it is now less than one hundred and eighty feet in width with a depth of only about three feet. The *Republican and Leader* closes by saying: "It is of vital importance to the future welfare and prosperity of our city that the dam at the head of Barron's island be built at once, or boats of any capacity will be no longer able to touch here."

SCIENTIFIC.

The Royal Library at Paris contains a Chinese chart of the heavens made about 600 B. C., in which 1460 stars are correctly inserted.

A new fire alarm, tried successfully at New Orleans the other day, consists of a thermoscope, having two vertical glass tubes, in each of which is placed a movable needle, one of the needles being attached to the wire connecting with the general fire alarm office, and the other is attached to a bell. When a fire breaks out, the mercury rises until it meets the needle, which is forced upward and turns in the alarm. Another instrument indicates the number of the house.

Cincinnati is taking the lead of American cities in the introduction of the electric light. It has an "Electric and Calcium Light Company," and this company has ordered a "gramme" machine from Paris. The electricity for the gramme machine is generated by steam power. The cost of putting the machine in operation will be between $1,500 and $2,000. It is of three-horse power, and its expenses after first cost will be simply for operating, including the attendance of one man. The result of the experiment in Cincinnati will be watched with interest.

The Jabloshkoff electric candles continue to be described by the London papers. At a trial made in a large tent covering one of the squares of the West India docks, four common lamp-posts were erected in the respective corners, and on one of these lamp-posts was placed an electric light, the electricity for which was generated by steam power in a magneto-electric machine of thirty-two magnets, each magnet composed of six plates. The steam engine, of two-and-a-half horse power, effected 480 revolutions of the magneto-electric machine per minute. The resulting light was so strong that the finest print could be read at a distance of thirty feet from the lamp. The electric light was then extinguished, and when sixteen gas-burners, four in each corner, were substituted, the effect was dismal beyond conception. It is found that loading and unloading ships can be carried on by the use of the electric candles by night as well as by day.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,
Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 213.*)

Trackways are, as has been mentioned, out of date. Where a common road does not suffice now-a-days, a railroad is built; but time was when trackways were of considerable importance. They consist, if of stone, of large, flat stones, say 12″ deep and 4–6 feet long by 14″–16″ wide, solidly bedded in two parallel rows, at such distance apart as to make of each row a track for the wheels. The space between is paved. They are of course very expensive, but cost little to repair, and enable a horse to pull a very great load. As has been mentioned, Telford made use of such a stone trackway, to avoid cutting down a hill, on his Holyhead road. There were two hills, each a mile in length, with an inclination of 5 in a hundred. It would have cost $100,000 to reduce this grade to 4⅙ in a hundred, but nearly the same advantage, in diminishing the tractive force required, was obtained by keeping the 5 in a hundred grade, with moderate cuttings and embankments, and making stone trackways, at a total expense of less than half the former amount.

"Plank roads," once so much in vogue in the United States, may not improperly be classed among roads with trackways, and, with them, also among the things that were. From their perishable nature, they can never advantageously do more than help the development of a new country, and in this, as well as other States, are yearly becoming more and more impracticable on account of the constantly increasing price of lumber.

ON THE RESISTANCE TO MOTION OR THE FORCE REQUIRED TO MOVE VEHICLES ON DIFFERENT KINDS OF ROADS.

Before, as well as since the introduction of railways, engineers in England, Germany and France made many experiments on the force necessary to pull different vehicles, at various speeds over various surfaces. To enumerate the details of all these experiments would be perhaps useless; a few general results only are here given.

Experiments, as above indicated, were made by Edgeworth, Count Rumford, Bevan, Macneill, Minard, Navier, Perdonnet, Poncelet, Flachat, Morin, Kossak, Umpfenbach, Gerstner, and no doubt others, a list of authorities that proves the subject to have been well nigh exhausted. The experiments of Morin, made in 1838–41, appear to have been made with a degree of care and accuracy, leaving nothing more to be desired, and the following table is an extract from his results,* and gives that fraction of the weight of the vehicle and load, which is required to move them on a level road:—

CHARACTER OF THE ROAD.	CHARACTER OF THE VEHICLE.			
	2- wheeled carts.	Trucks, 4 wh.; three and four horse.	4-horse stage-coaches, on springs.	2-horse carriages, body on springs.
Firm soil, covered with gravel 4″–6″ deep,	1/12	1/9	1/8	1/8
Firm embankment covered with gravel 1¼″–1½″ deep,	1/16	1/11	1/16	1/16
Earth embankment in very good condition,	1/41	1/26	1/26	1/26
Bridge flooring of thick oak plank,	1/10	1/46	1/47	1/42
BROKEN STONE ROAD.			walk / trot	walk / trot
In very good condition, very dry, compact and even,	1/15	1/24	1/48 / 1/41	1/49 / 1/42
A little moist or a little dusty,	1/13	1/18	1/34 / 1/27	1/34 / 1/24
Firm, but with ruts and mud,	1/13	1/24	1/31 / 1/18	1/32 / 1/19
Very bad, ruts 4″–4½″ deep, thick mud,	1/19	1/14	1/32 / 1/10	1/32 / 1/16
Good pavement, { Dry,	1/20	1/25	1/37 / 1/38	1/35 / 1/39
Good pavement, { Covered with mud,	1/20	1/20	1/44 / 1/33	1/46 / 1/34

* A full account of Morin's experiments on the resistance to motion of vehicles, on the wear caused by different vehicles on roads and on the loads different vehicles shou'd carry so as to produce the same wear, may be found in Morin, *Experience sur le tirage des Voitures, Paris*, 1842.

To take an example, suppose we have a truck weighing with its load 9,000 lbs. How many pounds traction will be required to move the same?

Ans.—On firm soil, gravel 4″–6″ deep, that is, a newly repaired road, as we often find it, (⅛ by table), 1000 lbs.; on best kind of embankment, (1/26 by table,) 310.3 lbs.; on broken stone road in good condition, (1/24 by table,) 166 6 lbs.; on broken stone road, deep ruts and mud, (1/14 by table,) 643. lbs.; on a good pavement, (1/65 by table,) 138.5 lbs. Or, since the tractive force of a medium horse when working all day is said to be about 125 lbs., we need in the first case, 8 horses; in the second case, 2½ horses; in the third case, about 1¼ horses; in the fourth case, about 5 horses; and in the fifth case, only one good horse to move the same entire load all day.

These facts expressed in the preceding page or two in striking, yet perhaps dry figures, can be nearly as well given in popular language.

Says a correspondent (Dr. Holland), of the *Springfield Republican*, writing from England, after describing the kind of horses in use there:—

"Now with all these horses the rule follows that every pound of muscle does just as much work on the road as two pounds do in America. The cab and omnibus horse does twice as much as the same horse does in America. The draft horse does as much in the dray as two ordinary dray horses in America, and the little horses, which are driven mainly in butchers' carts and grocers' carts, will tire a cab horse to follow them with no load at all.

"In connection with these statements it should be recorded that the speed of all vehicles in the streets of London, whether the localities be crowded or not, is at least a third faster than it is in corresponding streets in American cities. The ordinary speed of vehicles in London, in which passengers or light loads are transported, is one which is considered not entirely safe in Main street, Springfield, Mass., and one which, in some streets of Boston or New York, would be at once checked by the police. A man who sits in a 'hansom' finds himself driven at an unprecedented pace through crowded thoroughfares, and Yankee though he may be, he will often wonder whether he is going to bring up at last without a broken neck.

"I mention this matter of speed, particularly, because it shows that even more work is done by one horse in London, than by two in New York. He not only draws as large a load, but he travels with greater rapidity. The streets of London present such a spectacle of headlong activity as no American city can show, in consequence of the rapid passage of all sorts of vehicles through the streets. I might add to this statement, touching the superior speed of the London horses, a word about the greater weight of the carriages which they are obliged to draw behind them. All carriages are built more heavily in Great Britain than in America. They are built to last, and many of them seem to me to be superfluously heavy.

"The point which I wish to impress upon my American reader is simply this: that the English horse, employed in the streets of a city, or on the roads of the country, does twice as much work as the American horse similarly employed in America. This is the patent, undeniable fact. No man can fail to see it who has his eyes about him. How does he do it? Why does he do it? These are most important questions to an American. Is the English horse better than the American? Not at all. Is he overworked? I have seen no evidence that he is. I have seen but one lame horse in London. The simple explanation is that the Englishman has invested in perfect and permanent roads what the American expends in perishable horses that require to be fed. We are using to-day, in the little town of Springfield, just twice as many horses as would be necessary to do its business if the roads all over the town were as good as Main street is from Ferry to Central. We are supporting hundreds of horses to drag loads through holes that

ought to be filled, over sand that should be hardened, through mud that ought not to be permitted to exist. We have the misery of bad roads, and are actually or practically called upon to pay a premium for them. It would be demonstrably cheaper to have good roads than poor ones. It is so here. A road well built is easily kept in repair. A mile of good macadamized road is more easily supported than a poor horse."

Other results of Morin's experiments are as follows:

1. The force required to draw a vehicle, is directly proportional to the load, and inversely so to the diameter of the wheels; in other more common words, the tractive force increases in the same ratio that the load increases, and the diameters of the wheels decrease.

2. On a paved or well built macadam road, the tractive force is independent of the width of the tires, provided the same is more than three or four inches. On compressible roads, such as new gravel, on a meadow, etc., the tractive force diminishes with an increase in the width of the tires.

3. Other circumstances being equal, the tractive force is the same for vehicles with and without springs as long as the horses are not moving faster than a walk.

4. On paved and well macadamized roads the tractive force increases with the velocity, according to the law, that beyond a velocity of 2¼ miles per hour (3.3 feet per second) the increase of the tractive force is in direct proportion to the increase in velocity; this increment is however less, the softer the track or road and according as the vehicle is best provided with springs.

5. On soft earth embankments, or on sand or sods, or on streets newly covered with gravel, the tractive force is independent of the velocity.

6. On a well-made pavement of regular shaped stone, the tractive force, horses on a walk, is about three-fourths of that on a good macadam road, but with horses on a trot, the two are about equal.

7. The wear on the road is greater the smaller the diameter of the wheels and greater in the case of vehicles without, than for those with springs. Most road-rollers, as now in use, have two small a diameter besides being two light and consequently do not properly compress the road surface.

8 The tractive force, as well as the wear on the road, is greater in the case of vehicles that have their wheels placed at an angle with the vertical by reason of the ends of the axle-trees being bent down, than for those that have their wheels set plumb and the centre line of the axle-trees level.

PART II.

On the "Best Methods of Superintending the Construction and Repair of Public Roads in this Commonwealth."

In looking for a solution of this question the people of the Commonwealth man turn as they choose, either to the West or to the East, to see a guiding star; to the city of Chicago, or to the city of London, both under a republican form of government, alike or similar to that we live under. It lies in the establishment of a Board of Works, composed of a number of able men, well paid for their services, gradually changing in their membership in the Board who shall have this and only this as their occupation, and who can therefore be held responsible for their acts. This is the system that has been adopted both in London and in Chicago and with remarkable success and resultant benefits. There are many other systems in use in foreign countries all of which however seem to be inapplicable here, placed as we are, under so different forms of government; hence, though well acquainted with the systems adopted in France and in Germany, the writer has not described them here.

The history of "the Metropolitan Board of Public Works of the City of London" is about as follows:

What is known as the city of London consists in reality of a great number of what we should call towns, there called parishes, and of which the "*City of London*" is only one single member. Each one of these parishes had, and still has in most respects, its own local government, and in consequence took care of its drainage, its streets, etc., etc., as seemed best and as it liked, some better, some worse, and some not at all. This state of things in the matter of drains and sewers finally led to a most deplorable condition of affairs; there was not nor could there under these conditions be such a thing as a *system* of sewers, and consequently a proper and adequate drainage; the death-rate increased to an alarming extent and matters came to be universally regarded as past all endurance. What could be the remedy? No well grounded complaint could be made against the majority of the men composing the various local governments, since they were good and honest citizens, and hence no change in the separate goverements could ever bring relief. The fault lay not in the men, but in the system of ruling they were called upon to fulfill, that is, in the incompetent and faulty treadmill of government they were annually called upon to keep in its usual operation. It was then seen that by having an elected power to supervise and regulate the sewage affairs of the whole metropolis, a complete *system* of drainage could be carried out, and thus only. Such a regulating power is exercised by the metropolitan Board of Public Works, chartered by Act of Parliament and composed of members elected from all parts of London. It is perhaps in place here to explain what is meant by a *system* of sewers as the same definition will hold good in other matters; as for a *system* of roads, of drainage and irrigation of lands, etc. Perhaps the best illustration would be to refer one to the veins and arteries in the human body, or to the body of a tree, from its trunk through the branches growing smaller and smaller down to the smallest twig that may be on it. It will be at once seen how different any arrangement, in which may be the wisdom to contrive, the strength to uphold and the beauty to adorn, like this, is from a miserable patchwork such as cannot but arise where the separate parts of one whole are each left to guide themselves without any unity of action or design, as to their final resultant. The London Board of Public Works had some extraordinary powers conferred upon it, such as the right to levy assessments on real estate benefitted by their improvements, and others. Originally constituted merely to plan and execute a system of sewerage for the metropolis, this Board of Public Works soon showed itself so useful and beneficial in its actions that other matters were placed in its charge, such as the laying out of new streets, the building of the Thames embankment,—a work of exceeding great magnitude and importance,—and there seems to be no doubt that in all public works London will find it advantageous to employ its Metropolitan Board of Public Works.

In the city of Chicago there has been a Board of Public Works almost from the very start. It arose there from the union of the water supply and the sewerage commissioners, and has existed since May, 1861. No less than in London, it has proved to be of great benefit to the community; and it would have been impossible, under any other system, to have executed in so satisfactory a manner the many and useful public works for which Chicago is famed. At the risk of introducing in this place some very dry reading, a general synopsis of those parts of the city charter which relate to the Chicago Board of Public Works is here given. The whole may be found in a copy of "Laws and Ordinances, Chicago, 1866:"

SEC. 1. Establishes a body known as the "Chicago Board of Public Works," to consist of (3) three members, chosen by the people, one from each division of the city.

The first *three* chosen for one, two and three years; after that, one each year for three years.

SEC. 2. Each member of board shall receive annual salary of three thousand dollars (by Act of February, 1866); give bonds for faithful discharge of duties; pay over all moneys, papers, etc., at expiration of his term, or when ordered by city council.

(*To be continued.*)

OBJECTS OF INTEREST IN PITTSBURGH.

III.

The streets of the business portion of Pittsburgh are covered with the ordinary rubble pavement, and, on account of the heavy traffic, they are in a very rough state. The city has, however, gone into a systematic and extensive opening up of the suberbs by means of broad avenues, which have the roadways paved and the sidewalks completed, far beyond those portions where residences are numerous enough to warrant the expenditure. Here one may find all the kinds of road surface, in beautiful order, from a Macadamized roadway, through wooden pavement and stone up to concrete and asphalt. Time enough has not elapsed nor has there been sufficient heavy teaming over them, to determine their relative durability and economy. The cost of these improvements, which must strike one as at present uncalled for, has made a large proportion of the fifteen millions of debt with which the city is burdened. The tax or assessment upon many of the lots which border upon these avenues has exceeded the market value of the property, so that the cost is practically thrown upon the municipality.

The water works of this city are calculated to surprise if not to astonish the engineer who is acquainted with the designs adopted in other large cities. The original engines, first constructed about the year 1840, are still supplying the city, and they are certainly entitled to due credit for long and faithful service. They are, however, most unprepossessing in external appearance. They are situated upon the Allegheny river, quite in the heart of the city, and elevate the water some 116 feet into a reservoir upon the height above. A small pump at this reservoir supplies the high service. As might be expected from the locality and the date, these engines are modeled after the type of steam-boat engines which has been so common upon the western rivers. They are placed upon an inclined plane, of perhaps 20 degrees elevation, the steam cylinders being at the upper end and the pumps at the lower; the latter are generally completely under water. The connecting *rods* are of wood, the whole workmanship appears antiquated and rough, and the machines are taxed to their full capacity, the steam following the piston through the entire stroke. A Cooper pump of moderate power has since been added as a reserved and temporary means of supply.

As there is a decided need for more powerful engines, adapted to the present and prospective size of the city, new works have for some time been in progress several miles up the river, at East Liberty. The engines are now being erected and it is expected that two out of the four will be completed this fall, although considerable other work remains to be done before they can be connected with the reservoir and water can be forced through the rising main. These pumps are of the Lowrey pattern, and may be called double pumps of the single-acting Cornish variety. They strike one as very massive, if not cumbrous, and cast-iron appears to have been used in their construction without stint. Notwithstanding the size of their parts we could not feel all confidence in their strength; no pains seems to to have been taken to secure neatness of finish.

Without a sketch it will be quite impossible to convey a good idea of the arrangement of parts, as these pumping engines are quite unique in design. The engine being compound, the low pressure cylinder is situated directly behind the high pressure one, both being horizontal and one piston rod answering for both. The connecting rod is attached to the lower extremity of a vertical crank of three arms, a great bell-crank in fact, the three arms making angles of 120 degrees with each other, and being trussed with chains for strength, Below the ends of the other two arms are situated the pump cylinders, single-acting with plunger. Directly above the cylinders are the respective weight boxes, which are lifted on the up stroke and are expected alone to force the water into the main on the down stroke. To the lower crank pin is also attached a fly-wheel.

While it appears at first glance that the weight boxes will balance one another, yet one can soon see that the leverage with which they act around the crank bearings is constantly changing, and it is in this arrangement of the pumps that the inventor considers their merit to lie We did not feel prepared to admit the soundness of his reasoning, and think that a large mass of metal is being moved needlessly. A set of pumps of the same general design supply Allegheny City, on the other side of the river, and can be seen in operation there. They are of 14 feet stroke, 44 inches diameter of steam cylinder, and carry steam of a pressure of 110 pounds. They were not arranged with an adjustable cut off, and, although pumping against the constant resistance of the rising main to the reservoir, the engine would occasionally nearly stop on the centre. This was ascribed to a slight change of steam pressure in the boiler. The discharge from the main into the reservoir was very fluctuating. The large cast iron crank had broken at the point of attachment of one of the pump connecting rods, and had been repaired. A reported trial gave a duty of between thirty and forty millions.

After the expenditure of a large sum of money on a reservoir for these new water works at Pittsburgh, which reservoir was at a sufficient elevation for the major part of the city, and after it had been nearly excavated and partially stoned, it was argued and decided that it would be more economical to abandon this reservoir, build another on top of the hill, at 150 feet higher elevation, on a no more favorable site for construction and force the whole of the city supply to that height. than to raise all the water to the lower reservoir and have some small high service pumps located there for the supply of the more elevated portion of the city. The lower reservoir, partly built, has therefore been abandoned, and one has been completed on the summit. The result will be a heavy and useless pressure on all the mains and house fittings, unless the force is diminished by valves. The economy of raising a city's supply 150 feet, unnecessarily, is not at once evident.

The original estimate for these works was $3,000,000; $6,000,000 has already been spent.

OUR RAILWAYS AND THEIR ECONOMICAL USE.

II.

Political economy, considered rather a dry and uninteresting subject by the general public, will need to be taken up as a study, and its principles thoroughly understood by the thinking, intelligent men of the world before a comprehensive view of the causes of the present depression in business can be obtained and a genuine remedy for its relief proposed. That our entire social and commercial fabric is underlaid by these principles and governed by them, seems to be generally admitted by the thinking men of the community, and in the fulfillment of the wonderful predictions of a well known English political economist, we cannot but feel confirmed in our belief in the unchangeability of these principles. Now, society is made up of *individuals* and it is by the force of persistent and intelligent individual investigation into the relations of cause and effect, that, in time, a solution of many of the difficult problems which now are vexing the industrial and commercial worlds will be found. It is this personal investigation that we are now advocating, and we know of no class of men who are more competent to grapple with the problems involved in the successful administration of our railway system than the readers of this journal. A large proportion of them are now, or have been, engaged in the construction and operation of railways, and if we shall have conveyed to them any new ideas on the economies of transportation, in this series of papers, which they may be led to develop, our labors will not have been in vain.

An intelligent discussion of our railway system is synonomous with that of political economy, and in order to ascertain their effects upon business, we will examine some of the forces which have been at work during the past few years first considering some of the causes that led to the adoption and extension of our present system of railway transportation.

Our country was first settled along the Atlantic coast and as the population increased, it pushed westward and up the navigable streams. Then means of communication were needed, to supply their wants and dispose of their surplus products. At first the natural water courses only were used; then common roads were made; as communities advanced in prosperity and increased facilities were demanded for their commerce, canals, which however could only be constructed in favorable localities, were introduced. These gave such an impetus to business that people then realized even more than now, the importance of transportation. The divides between the Atlantic slope and Mississippi river were too formidable for the construction of canals, and they could only be made between the lakes and more favored cities, either upon the seacoast or some great river.

This gave to the various cities unequal advantages, and the rivalry of the business men in the less favored localities, induced the adoption of such a system of communication, as could pass over the great divides of the water courses. The enterprising merchants of Baltimore in 1827, were the first to procure a charter for a railroad in the United States, and thus was inaugurated the pioneer line of internal communication, between the East and the great undeveloped West. The genius of its engineer B. H. Latrobe, in overcoming the natural obstacles in crossing the great divides, at that time without precedent, must ever be considered as one of the most important and marvellous feats of engineering.

Other charters soon followed:—

				Increase in ten years.
In 1830	23	miles	were in operation.	
In 1840	2,818	"	"	2,795
In 1850	9,021	"	"	6,203
In 1860	30,635	"	"	21,614
In 1870	52,398	"	"	22,263
			Increase in five years.	
In 1875	74,658	"	"	22,760

It will be seen by the above that in 1850 we had 9,021 miles, yet in 1860 it was more than trebled. In the next ten years, two-thirds as many miles had been built, as in the previous thirty, and in the next five as many as in the past ten. Until the year 1850 many of the railway lines were simply local, and constructed in a very inferior manner compared with those of to-day, and being built without any view to a general railway system, they exerted but little influence on the commerce of the country.

The years 1850 and 1851, marked a distinct era in different parts of the country in railway construction. Lines were consolidated; more powerful locomotives were introduced; cars were improved; and the rail and tie system substituted in place of the strap rail and stringer. The Erie railway was opened in 1851 to the lakes, and the N. Y. Central was relieved from paying toll on its freight to the State. The year 1850 was an important epoch in western railway building, as Congress granted to Illinois 2,595,003 acres of land, to aid in the construction of the Illinois Central, Mobile and Chicago Railroad. Extensive land grants were made to other western lines and a great impetus was thus given to railway construction.

The fertile prairies of many of the western states had already attracted a large population who were principally engaged in agricultural pursuits, their commerce being entirely conveyed on the Mississippi and tributaries, and the great chain of lakes. The cost of transportation was so much, and then only available to the limited territory adjacent to the rivers and lakes, that corn was often cheaper fuel than wood or coal. Chicago, already the mart of the northwest, was pushing its railway construction both east and west, and in 1853 it had rail communications east, and in February 1854, lines were opened to the Mississippi—a marked epoch in western commerce.

The demand for iron and iron rails gave that industry great activity in all branches, and railways were given a vast amount of business in transporting material for new roads. The demands were so great on the manufacturers that they could not fill their orders, and increased facilities of production were provided, while mines to provide the raw material were being constantly developed, especially those of Lake Superior, which supplied most of the ores for western rails of early times. To meet the great demand for iron, the conversion of the raw material by the small charcoal furnace was too slow, and better facilities were demanded, and in north eastern Ohio was found a coal which, to smelt ore, could be used in its raw state in much larger furnaces. At this time it required about four tons of coal to make one ton of iron, and it was found to be cheaper to send the ore to the coal mines instead of *vice versa*.

All these circumstances produced their effects upon the business of the country. Great local industries were

developed far in excess of the absolute demand, and which declined as improvements in manufactures developed in other places. From the table we see that in 1860 a great increase in miles of road had been built, in fact in the past ten as much as in the former thirty, which of course was giving some branches of manufactures a great stimulus.

In 1861, the civil war closed the southern seaports, and much of the business which had heretofore gone down the Mississippi sought the ocean by other routes.

The inflation of values consequent upon the war's demands and the period of wild extravagance that followed are too well known to need more than passing mention here.

The war closed in 1865 and many of the soldiers returned to their homes to engage in the business of the country. The waste of a great war was to be *endured*, but we still continued in a spirit of speculation; real estate advanced in the country as well as in cities, where its purchase and sale became a perfect mania, and adjacent farms were laid out in city lots, far in excess of any possible demand. From a careful estimate in a city of 100,000 people in 1870, sufficient territory was divided into lots to accommodate a population of 400,000, and large amounts of capital were invested to meet simply what was a speculative demand; improvements were projected at inflated prices, and municipal debts increased on a false basis, to an alarming extent.

THE LAKE CRIB OF THE CHICAGO WATER WORKS.

It may be interesting to many of our readers to know the extent of the repairs now being executed upon the Lake Crib, or more properly, the breakwater around the Inlet shaft to the tunnel. This tunnel, it will be remembered, extends from the Pumping works near the Lake shore a distance of a trifle over two miles, in an east northeasterly direction out into Lake Michigan, and is the means adopted to supply Chicago with purer water than that originally drawn from the basin close to shore.

The recent controversy in which the stability of the crib was so seriously questioned, has, doubtless, contributed largely to make the structure familiar to engineers interested in whatever pertains to water works; and, while it may be added, that all engineering works founded upon empirical rules are subject at any moment to like discussions by reason of the diversity o judgment and experience of the engineers under whose notice they may be brought, the Lake Crib after many years of buffetting and ill usage from heavy weather and thick ice, stands firmly, attesting the skill of the engineer who designed it.

Some seven years ago, in order to preserve its sides from injury from ice or other causes, a sheeting of pine plank was spiked to all its faces—the crib being pentagonal in form. Two years was sufficient to destroy this, when oak was substituted, which has lasted, with its customary durability, for the past five years, the corners having only received any serious injury. To render these angles still more secure, and to oppose a more durable material to the abrasive action of the ice, it has been decided to protect the five corners with wrought iron angle plates. These angle plates extend six ft. each way from the apex of the angle, are four ft. deep with holes for sixty bolts and weigh about 1600 pounds each.

A short time since, contracts were let to the Western Submarine and Wrecking company of Chicago, Capt. Peter E. Falcon, superintendent, to execute the necessary repairs, which were instituted by divers making exact patterns of each corner, so that the angle pieces being made complete at the shops, nothing was left but bolting them in place upon their arrival at the Crib, and no other work is necessary upon the sub-structure this season.

The joints of the masonry of the super-structure within reach of the waves and ice need repointing, which is being done. The cement work, between the masonry superstructure and the ballast and top of the crib proper, were found to have suffered the most from the action of the elements. Into the crevices thus formed, oak wedges are driven and the joint carefully filled and pointed with cement, leaving the work as firm as it ever was. The report of the divers as well as the personal observation of Mr. Chesbrough, prove the satisfactory state of the structure. Exposure to the winds and waves of Lake Michigan during many years has failed to affect its stability, and looking at the very moderate repairs required thus far, there is no reason to doubt its permanence.

OUR thanks are due to the Keokuk *Constitution* for advance sheets of the very complete description of the DesMoines Rapids Canal appearing in that journal this week, and to which we would refer such of our readers as are interested in the subject. We would publish it but for the fact that we have already done so in Vol. III. ENGINEERING NEWS, pp. 336 and 374, which are now out of print.

An effort to shake off the barnacles that are fattening upon it has been inaugurated by the B. & O. R. R. Co., which advertises as follows:

"The Baltimore & Ohio Express is now organized and ready to receive business for all points on the line of the Baltimore & Ohio R. R., including Baltimore, Washington, Staunton, Va., Martinsburg, W.Va., Cumberland, Md., Wheeling, W. Va., Pittsburgh, Pa., Connellsville, Pa., Bellaire, O., Barnesville, Cambridge, Zanesville, Newark, Columbus, Mt. Vernon, Mansfield, Shelby, Sandusky, Munroeville, Tiffin, Fostoria, Defiance, and intermediate points on the line.

"The Baltimore & Ohio Railroad company now propose to operate their entire express business, but will not for the present, undertake to do a money, collection, or C. O. D. business. This branch of the business will be assumed as soon as arrangements can be completed."

How long this spasm of virtue will last, and how far it will be imitated by other companies remains to be seen. It is, however, a promise of better times coming for the owners of railroad property who have been bled freely by the barnacles.

LAND SURVEYING IN THE DOMINION.

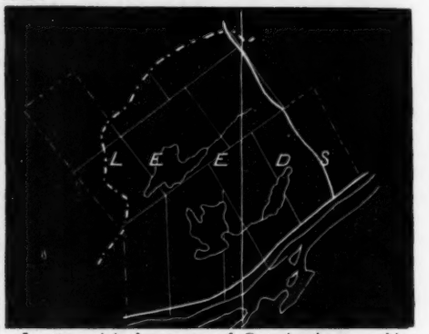
BY P. L. S.

V.

"Variety is the spice of life" and by early spring I had wearied of the semi-barbarous region of the Ottawa district, and so, availing myself of the privilege of transferableness of a surveyor's apprentice, I opened negotiations with another P. L. S. whose practice lay in the thickly populated and fertile regions bordering on the St. Lawrence River between Kingston and Brockville, and for the four months necessary to complete my year, I agreed to give him forty dollars and my services, and to receive board and lodging, and practice in return. I accordingly shook from off my feet the moccassins and mud of the backwoods, with its scratching, roystering, whiskey ("forty rod") guzzling associations, and instead of the noisy tavern, I suddenly found myself domiciled with a Quaker surveyor and farmer in "a very quiet neighborhood." There was a most radical difference between the surroundings of my second and my first service. My old master's name was —— ——; he was 6 feet 5 inches high, and modest and bashful in proportion; he was a mathematician and a surveyor by nature and education; could outwalk a camel; out-diet an ostrich; could yell louder, swear farther and gesticulate more wildly than any transit man I ever saw, and was quick, alert, and accurate in every movement; his possessions consisted of a first-rate new transit and chain, a horse that he traded whenever an opportunity offered, harness, and an old sleigh, a book of tables, a copy of the surveyor's Act, and a standard rod for testing the chain.

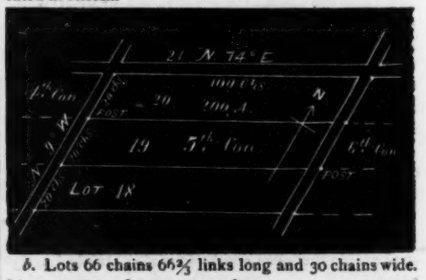
My new master's name was —— ——; 5 feet 6 inches high and self conceited in proportion; he had a limited education; was as slow as "pitch in winter," was fussy and finical; he had a farm, a house, a wife and a baby; "a horse, a cow, and a pig," and so, according to Dr. Franklin, was entitled to a general "good morrow:" he always took his best wardrobe with him when we went surveying, and, if it was cloudy, had a man with an umbrella go along; he had a theodolite graduated to ten seconds, and he always repeated angles three times and took the mean; he never swore, and seldom gesticulated, except in a quiet way; always projected his lines ahead and so was never near his party, but was either fussing over his old ten second theodolite, or walking between it and the axemen; he was a neat, close-fisted, simple, little man, and as a surveyor, was as accurate as an automatic machine, and had a very fine practice withal. I remained with him four months, and had a first-rate, though rather a sleepy time of it. We had in the four months twenty-six days of actual practice and of that, nine days were spent in the survey and subdivision of *ten* acres into *blocks* in the flourishing town of Brockville. We would chain the blocks east, and then chain the blocks west; then we would measure them with a pole east, and after that measure them with a pole west, and ditto north and south and back again, and we would take notes and angles and offsets during the day, and astronomical observations during the night. The survey was for the present Governor Richard's, of Manitoba (or some other region near the Arctic pole), and as we lived in his fine house during the survey, and as he was just then engaged in a fruitless political contest for the title of M. P. and as we spent one day hurrahing for him at the nomination, I think it was about the nicest survey I was ever on, athough it was very tedious carrying the old pole about the little patch, and dragging the huge chain for so many days, when two days at most were more than sufficient to do the work.

Our other work was exclusively on farm surveys. The land in the old parts of Ontario is subdivided into townships, the boundaries of which are arbitrary lines and conform to no uniform direction, as shown in cut, and upon what principle, if any, they were laid out, I am unable to state. The newer townships have been subdivided with reference to uniformity in area and direction of boundaries, and the U. S. rectangular is now the adopted system in the survey of the public lands.



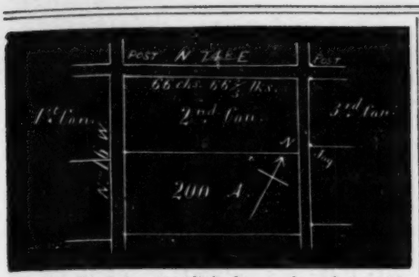
In the original surveys of Ontario, the townships were laid out in strips which were either 100 or 66.66⅔ chains deep by 20 or 30 chains wide, making in each case 200 acres to the lot. These strips or tiers of land were called "Concessions" and were separated by a road allowance of one chain in width, which was given for the purpose of public highways. The concessions were numbered, and so were the lots in each concession so that a farm is described as, say lot No. 15 in Concession No. 6, in the township of S. Crosby, County of Leeds; and to find this property, the surveyor, after consulting his map of the County and seeing how the "Concessions" were numbered, knew that he had to go 15 times 20 or 30, chains distant from that side of the township from which the lots were numbered. In laying out the "Concession" three principal plans were adopted, which we here give:—

a. Road allowance 1 chain wide. In the original survey only the Concession lines were run out and posts were planted at the *fronts* of Concession only, as indicated in sketch.

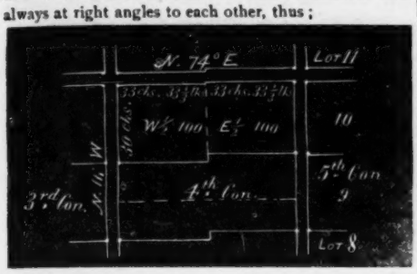


b. Lots 66 chains 66⅔ links long and 30 chains wide. Lines run from front to rear, thus:

The same remarks apply to this case as to the first one. But, I may here add that the "jogs" almost always occur, on running the line through to the rear of the Concession as indicated in the latter sketch—the jogs occuring at the side roads the same as in the side lines.



c. Lots 66 chains, 66⅔ links long and 30 chains wide. *Double-fronted* Concessions—lines run each way to middle of Concession. Side lines and Concession lines always at right angles to each other, thus;



In this case posts were planted on either side of the Concession road. This plan, while possessing certain advantages over the other two, is on the whole the worst one. The greatest objection to it is the *jogs* coming in the middle of the Concession; and so roughly done were some of our original surveys, that in my own practice I have frequently found jogs of more than half the width of the lot and in one case the east and west halves of the same lot did not touch each other by some 23 links. In case of side roads especially this is extremely awkward. These side roads occur between every 5th and 6th lot as a rule throughout the Province.

The method of surveying farm boundaries is fully described in the following instructions which are taken from the Act:—

72. Every surveyor shall run all divisions or side-lines parallel to that boundary line of the concession in which such lands are situate, from whence the lots are numbered, provided such division or side-lines were intended, in the original survey to run parallel to said boundary.

73. When that end of a concession, from which the lots are numbered, is bounded by a lake or river, or other natural boundary, the said division or side-lines shall run parallel to the boundary line at the other extremity of such concession, provided their course was intended, in the original survey to be parallel thereto, and that such boundary line was run in the original survey.

74. When in the original survey, the course of the division or side lines in any concession was not intended to be parallel to the boundary line at either end of such concession, they shall be run at such angle with the course of the boundary line at that end of the concession from which the lots are numbered, as is stated in the plan and field notes of the original survey, of record in the office of the Commissioner of Crown Lands, provided such line was run in the original survey, or with the course of the boundary line at the other extremity of the said concession, if the boundary at that end of the concession from which the lots are numbered was not run in the original survey; or if neither of the aforesaid boundaries of the concession were run in the original survey, or if the concession be bounded at each end by a lake or river or other natural boundary, then at such angle with the course of the line in front of the said concession, as is stated in the plan and field-notes aforesaid.

75. If any division or side-line between lots, or proof-line intended to be parallel to the division or side-lines between lots, was drawn in any such concession in the original survey thereof, the division or side-lines between the lots therein shall be drawn parallel to such division or side-line or proof-line.

76. When two or more such divisions or side-lines or proof-lines were drawn in the original survey of such concession, that division or side-line or proof-line which is nearest to the boundary of the concession from which the lots are numbered, shall govern the course of the division or side-lines of all the lots in such concession between the boundary of the concession from which the lots are numbered and the next division or side-line or proof-line drawn in the original survey, and such last mentioned line or proof-line shall govern the course of the division or side-lines of all the lots up to the next division or side-line or proof-line drawn in the original survey, or to the boundary of the concession towards which the lots are numbered, as the case may be.

78. The front of each concession in any township in Upper Canada, where only a single row of posts has been planted on the concession lines, and the lines have been described in whole lots, shall be that end or boundary of the concession which is nearest to the boundary of the township, from which the several concessions thereof are numbered.

79. In those townships of Upper Canada which are bounded in front by a river or lake where no posts or other boundaries were planted in the original survey on the bank of such river or lake to regulate the width in front of the lots in the broken front concessions, the division or side-lines of the lots in such broken front concessions shall be drawn from the posts or other boundaries on the concession line in rear thereof, parallel to the governing line determined as aforesaid to the river or lake in front, and when the line in front of any such concession was not run in the original survey, the division or side-lines of the lots in such concession shall be run from the original posts or monuments placed or planted on the front line of the concession in the rear thereof, parallel to the governing line determined as aforesaid to the depth of the concession—that is, to the centre of the space contained between the lines in front of the adjacent concessions, if the concessions were intended in the original survey to be of an equal depth or if they were not so intended in the original survey, as shown on the plan and field-notes thereof of record in the office of the Commissioner of Crown Lands, having due respect to any allowance for a road or roads made in the original survey and a straight line joining the extremities of the division or side-lines of any lot in such concession drawn as aforesaid, shall be the true boundary of that end of the lot which was not run in the original survey.

80. In those townships in Upper Canada in which the concessions have been surveyed with double fronts, that is, with posts or monuments planted on both sides of the allowances for roads between the concessions, and the lands have been described in half lots, the division or side-lines shall be drawn from the posts at both ends to the centre of the concession, and each end of such concession shall be the front of its respective half of each concession, and a straight line joining the extremites of the division or side-lines of any half lot in such concession, drawn as aforesaid, shall be the true boundary of that end of the half lot which has not bounded in the original survey.

81. And whereas some of the double front concessions in the townships in Upper Canada, are not of the full depth, and doubts have arisen as to the manner in which the divisions or side-lines in such concessions should be established:—Therefore in such concessions the divisions or side-lines shall be drawn from the posts at both ends thereof, to the centre of the concession, as provided in the last preceding section of this Act, without reference to the manner in which the lots or parts of lots in such concession have been described for Patent.

82. In those townships in which each alternate concession line only has been run in the original survey, but with double fronts as aforesaid, the division of side-lines shall be drawn from the posts or monuments on each side of such alternate concession lines to the depth of a concession, that is, to the centre of the space contained between such alternate concession lines, if the concessions were intended in the original survey to be of equal depth, or if they were not so intended, then to the proportionate depth intended in the original survey, as shown on the plan and field-notes thereof of record in the office of the Commissioner of Crown Lands and each alternate concession line as aforesaid shall be the front of each of the two concessions abutting thereon.

83. In all cases where any Crown Patent of Grant, or other instrument, has been issued for several lots or parcels of land in concessions joining each other, the side-lines or limits of the lots or parcels of land therein mentioned and expressed, shall commence at the front angles of such lots or parcels of land respectively, and shall be run as hereinbefore provided, and shall not continue on in a straight line, through several concessions, unless the side-lines or limits, when run as aforesaid, intersect the corresponding posts or monument in the front of the concession next in rear, that is to say, each such lot or parcel of land shall be surveyed and bounded according to the provisions of this Act, independently of the other lots or parcels mentioned in the same grant or instrument.

84. Every Land Surveyor employed to run any division-line or side-line between lots, or any line required to run parallel to any division-line or side-line in the concession in which the land to be surveyed lies, shall, if it has not been done before, or if it has been done, but the course cannot as such time be ascertained, determine by astronomical observation, the true course of a straight line between the front and rear ends of the governing boundary line of the concession or section, and shall run such division-line or side-line as aforesaid, truly parallel to such straight line, if so intended in the original survey, or at such angle therewith as is stated in the plan and field-notes as aforesaid, which shall be deemed to be true course of the said governing or boundary line for all the purposes of this Act, although such governing or boundary line as marked in the field be curved or deviate otherwise from a straight course; and the same rule shall be observed, if a line is to be run at any other angle with a front or other line, which may not be straight.

85. In all cases when any Land Surveyor is employed in Upper Canada to run any side-line or limits between lots, and the original post or monument from which such line should commence cannot be found, he shall obtain the best evidence that the nature of the case admits of, respecting such side-line, post or limit; but if the same cannot be satisfactorily ascertained, then the Surveyor shall measure the true distance between the nearest undisputed posts, limits or monuments and divide such distance into such number of lots as the same contained in the original survey, assigning to each a breadth proportionate to that intended in such original survey, as shown on the plan and field-notes thereof, of record in the office of the Commissioner of Crown Lands; and if any portion of the line in front of the concession in which such lots are situate, or boundary of the Township in which such concession is situate, has been obliterated or lost, then the Surveyor shall run a line between the two nearest points or places where such line can be clearly and satisfactorily ascertained, in the manner provided in this Act, and shall plant all such intermediate posts or monuments as he may be required to plant, in the line so ascertained, having due respect to any allowance for a road or roads, common or commons, set out in such original survey; and the limits of each lot so found shall be the true limits thereof.

86. In those townships in Upper Canada in which the side lines of the lots were drawn in the original survey, every Provincial Land Surveyor, when called upon to determine any disputed boundary in any such townships, shall ascertain and establish the division or side-lines of the lots, by running such side-lines as they were run in the original survey, whether the same were in the original survey run from the front of the concession to the rear, or from the rear of the concession to the front, and shall adhere to all posts, limits or monuments, planted on the division or side-lines in the original survey, as being or designating corners of lots under such original survey.

ON THE FAILURE OF THE ASHTABULA BRIDGE.*

(*Continued from page 216.*)

The second and only other point of interest in this discussion, covers the prevention of such disasters for the future. The first impulse with most people, when any thing goes wrong is to devise some legislation that will prevent its repetition. There is a natural feeling that government is paternal in its character, without whose interference the affairs of state and corporations cannot prosper. Doubtless, laws are necessary, but they are evils at best, out of which frequently grow greater difficulties, than those they were devised to overcome. Laws beget laws, and their tendency is toward interference with wholesome, legitimate development. I am a believer in legislation only as a matter of last resort, prefering that evils should work their own correction if possible, from within outward, rather than be suppressed from the outside. The former is natural and proceeds from self interest if not from higher motives, while the latter is interfering, and therefore creative of antagonism. These remarks I conceive, apply with great force to railroad interests, which in some parts of the country have been badgered nigh unto death with well-meant legislation. The object of the owners of a railroad is to make it pay, and they are well aware that to do so their road must be kept in a good, that is, safe condition. They know full well, for instance, that a bridge disaster means a drain on their treasury, and in the case of the Lake Shore railroad, this drain, growing out of but one disaster, will probably not be covered by less than a million dollars—all things considered damage to property, to life and injury to business.

Bad bridges are built through ignorance, but their number is wonderfully decreasing year by year, and sad as the accident at Ashtabula was, the notoriety of it with all the attending circumstances, has reached every railway official in the land, and they are beginning to realize that iron bridges are dangerous unless intelligently built, that such are constructions which require care and that the foreman of bridge repairs is not the proper person to pronounce upon their safety or manner of performing their work. I venture to say that there is hardly a railway in the country that has not been inspected in *some* way, as to its bridges, since last December. It is to be hoped that experts have been employed, without whose knowledge, inspection will not amount to much. There are, doubtless, still standing in daily service, iron bridges that are dangerous for the safe passage of trains, from insufficient transverse bracing, unguarded floors, or weak ones, if in no other particu-

* Discussion by the American Society of Civil Engineers.

lars, and it will be a very great economy for the roads that have not done so, to employ at the earliest moment, some one who *knows* the points to be looked after.

This then, in my judgment, is all that is needed for the prevention of bridge accidents: "Have all bridges examined at least once yearly, by an expert who has had experience as a bridge builder, as well as being a theoretician." Railroad managers can rely upon it if such a policy is honestly carried out, that in less than two years there need not be a dangerous iron bridge in America, or a bad one built hereafter.

As an illustration of the idea that, where possible, it is always best to allow evils to work their own cure through natural channels, take the recent action of the Reading Railroad Co., with reference to the Brotherhood of Locomotive Engineers, an organization that prosperity and discipline had made unbearable. Massachusetts and some other States felt driven to legislation to protect the roads and the public from the exactions and annoyances of the arrogant engine drivers. With one general order, the vitals of the Brotherhood have been pierced by the Reading Co., and now that Mr. Gowan has shown how to "stand the egg on its end," doubtless the other roads will follow suit, and it cannot be long before the Brotherhood will be among the things that were. Such action, on the part of this railroad, has been worth volumes of laws, in that the moral effect of establishing one's own mastery, enforces a respect that laws are powerless to accomplish, not only in relation to the Brotherhood, but in all its relations to labor.

Holding then to the doctrine of the least possible governmental interference, and also to the principle that men should be selected for positions of responsibility on the score of their experience and training in any special direction, it is impossible for me to approve of the "Adams" bill introduced into the House of Representatives by Mr. Garfield, covering the appointment of army engineers as a commission to investigate railway accidents, and report on the most approved means of preventing the same. On its face it appears innocent enough, not likely to interfere with the liberties of corporations, but it authorizes the Commission to report upon the means of prevention of accidents, which would be a useless provision, unless it was intended to frame laws based thereon as to what companies should, or should not do, growing out of this bill. I can imagine various army inspectors appointed for the different departments of railway service, which would very much interfere with the railway interests. It is a very serious objection to the bill, that it is committed to the hands of army engineers to carry out its provisions. These gentlemen are not fitted by occupation or training to sit in judgment on railway affairs, complicated at best, and involving for their proper estimation, a knowledge gained by experience. As well appoint civil engineers as experts to sit upon the best method of preventing the bursting of artillery, or the construction of a fort. So far as the bill covers the compiling and classification of railway accidents, or the sitting of the Commission as a coroner's jury, the army engineers could do that work well and the results would be useful as statistics, but the recommending of preventions, involves the experience and judgment of the practical railroad manager and constructor, to whom alone that department of the bill should be allotted. I think the bill could be modified so as to operate usefully, if confined to the simple idea of compiling statistics, a class of work the government ought to do a great deal more than it does, but I most emphatically say "hands off" at any indication of government non-experts interfering with our railroads or other institutions.

Mr. Squire Whipple.—Were I a juror upon an inquest in the case of the Ashtabula bridge, my verdict would be that the structure owed its destruction to an excess of 6-inch I beams used in the construction of its compression members. If the old man in the fable, who broke the bundle of sticks one by one, to enforce upon his sons, the lesson of strength in union and weakness in division, had used a solid timber as against the bundle of small rods, the illustration would have been still more striking; and, if half the material in the braces, and a little more than half that in the upper chord of the bridge, had been used in the form of Phœnix columns, or other well proportioned hollow trunk form, the result would, undoubtedly, have been vastly better.

It seems to be quite evident, as well as generally conceded, that the failure commenced at the second panel length from the west abutment, by the yielding to deflection of the second set of braces of the south truss; possibly preceded and partially induced by the breaking of one of the lugs rising upon the cast iron angle block. It may never be known which of these two results preceded the other, and practically it is of little consequence that it should be, as that mode of construction is not likely to be repeated, and if there are other specimens of the same kind of practice, the catastrophe in this case will call attention to them, and a like result, in regard to them, will be averted.

The power of the I beam to resist flexure at right angles with its web, is, of course very small; so large an excess of its material being in and near the web, and offering slight resistance to flexure. Allowing half the material. 1 inch, and the other half, 4 inches diameter (perpendicularly to the web), giving an average of 2½ inches, the length of the brace, about 22 feet, would be 105 diameters, and the half-length 52½ diameters. Now, the clamping of the braces in the centre could only prevent flexure in opposite directions by the several pieces. In case half the pieces were inclined to deflect northward, and the other half southward, in equal degrees, the tendencies would be neutralized, and the lengths practically reduced to 52½ diameters. But, were all, or a majority of the pieces inclined one way, as they almost certainly would be, the opposite tendency of the minority (if any) would be overcome, and these being forced past the point of equilibrium, they would all tend the same way, and the brace to all practical intents would have a length of 105 diameters, with an absolute power of resistance considerably less than that required for the actual stress shown from the parts in question, by Mr. Macdonald's strain sheet.

The section of iron in the six pieces constituting this brace, was about 58 square inches, and we see that under conditions easily supposable, and scarcely improbable, failure could have been predicted with certainty; whereas one-half of that section in the Phœnix column of 10 or 12 inches in diameter, would have sustained the compression with as near an absolute certainty as is attained in practical matters of this kind.

It seems hardly necessary to criticise this structure in detail or to great length. As Mr. Macdonald pertinently remarks, the plan is exceptional in design and execution, and so radically faulty in many particulars as to be at once discarded by every intelligent bridge engineer of the present day. And that it endured so long with faults so obvious, should serve to confirm rather than impair public confidence in the safety of well designed and constructed iron bridges, such as are built by most of the prominent builders of this country.

I would remark further, that while the general arrangement and outline of the trusses of this bridge (the trapezoid with verticles and diagonals in the web) was one of the best general forms in use, and while the material was in even super-abundance, and of good quality, a weak and inefficient structure was produced by neglect of certain important principles which should never be lost sight of, in arranging the details of a bridge truss. It was faulty to introduce oblique thrust members and tension verticals instead of the reverse, in the web. By this means the thrust members were unnecessarily increased in length, and the efficiency of the material diminished. This remark is not applicable in case of trusses *without* vertical members, in which the oblique thrust members are prevented from deflection in the plane of the truss by connection with tension members at the crossings, and from deflection transversely to that plane, by the tension of crossing members as well as by greater diameter transversely; whereby the efficiency of material in thrust members is preserved.

But it was a much greater fault, and probably the one mainly leading to the fatal result, to divide the material of the braces and upper chord into 5 or 6 slender bars, affording but little mutual support laterally, instead of consolidating a smaller amount of material in single efficient members of large diameter and lateral stiffness.

The practice, moreover, of distributing the floor beams over the upper chord between supported points imparting a very considerable lateral strain in addition to the compression which it is the main function of that chord to sustain, is a practice meriting disapprobation and discouragement.

Mr. Charles Hilton.—As has been shown by Mr. Macdonald, it is quite evident that the failure of the bridge began in the second panel division from the west end of the south truss, by the bending of the upper chord of the second main brace or perhaps of both simultaneously, although the iron in both chords and braces at this place was much less severely strained than corresponding members in other parts of the bridge; and hence it would appear, that there must have been some defect in the material or workmanship at that point, or some other assisting cause aside from the ordinarily recognised strains due to the load upon the bridge.

Mr. Macdonald thinks that the explanation may be found in the weakness of the lugs on the second top-chord angle block. As described, this angle block had two lugs cast upon its upper surface, through which the horizontal component of the strain on the main braces was transmitted to the two beams of the upper chord. On gathering up the wreck, one of these lugs was found to have been broken off, as was the case with the lugs on many of the other angle blocks, the fracture in this and several of the others showing defects in the casting, as has been explained. But as the other lug upon this angle block remained intact, I find myself unable to understand clearly how the breaking off of one of the lugs could have caused the bridge to fall while the other lug remained unbroken. The first effect of breaking off one lug, would be, to throw a double strain on the other, and it seems to me that it must have been the next thing to give way, in the course of destruction.

In seeking for a more probable auxiliary cause of failure, I have been led to consider some circumstances that appears to have either escaped the notice of other investigators, or have not been considered by them entitled to serious consideration.

Ashtabula station is about 1,200 feet west of the west end of the bridge, and about 500 feet west of the station is a level railway crossing. The Ohio State laws require all trains to come to a full stop not less than 400, nor more than 800 feet from all level railway crossings, and hence all trains going west on the Lake Shore & Michigan Southern R. R. must be brought to a stop, with the engine from 900 to 1,300 feet west of the west end of the bridge, and it seems all together probable that in most cases the brakes have been applied while the trains were upon the bridge. Let it be born in mind, that all such trains were upon the south track, one rail of which lay over the middle of the south truss. Now whenever the brakes were applied to the train, a force equal to the friction upon the wheels was transmitted to the track, tending to force the rails to move in the direction in which the train was moving.

Assuming the connections of the bridge floor and track with the roadway and track westward from the bridge to have been perfect and unyielding, no effect would have been produced upon the framework of the bridge; but on the other hand, if the wooden platform and rails on the bridge were free to move at the abutments in the direction of the rail line even to a small extent, a force equivalent to the friction of the brakes on the wheels upon the bridge must be transmitted to the abutments through the framework of the bridge itself. I consider it not at all improbable, that generally the connection between the bridge floor and the track with the roadway and track at either end was so far imperfect and yielding that a considerable portion of the force exerted through the brakes upon the track, had to be resisted by the bridge truss and mainly by the top chord and main braces, of the west half of the bridge—the maximum stress from this cause occurs near the west end of the truss. From what I have been able to learn in relation thereto, I am inclined to the belief that the engineer of the second engine of the ill-fated train, applied the air brakes just as he reached the west end of the bridge, and that the increased stress thereby produced upon the upper chords and main braces near the west end of the truss may have been sufficient to have been the immediate cause of failure at that moment, and at that particular place.

(*To be continued.*)

THE FAST-FREIGHT BARNACLES.

The discussion of the labor problem, especially as it involves railroads, covers a wide field. Our reporters have investigated one phase, and in our last issue were printed the results, which gave one very important reason why railroads are unable to pay dividends and are compelled to reduce the wages of their employees. In an interview with a very prominent railroad official, the latter let in a flood of light upon this subject, speaking in a general way of railroad business. One case will illustrate the whole. In order to attract custom, the railroads allow a rebate to heavy shippers. A large mercantile house makes an annual contract with the roads or with the fast-freight lines which live upon the roads at a certain rate, say 75 cents per hundred. The house pays this rate, and then at any time it pleases lays claim to a rebate of 45 cents, which is allowed, leaving 30 cents which must be divided between three or four companies and their "Red" "White" or "Blue lines. Deducting the numerous minor charges from this amount, and it is easy to see that next to nothing goes into the treasury of the company to be divided among the stockholders. Therefore it happens that while the expenses of the road may be light and the amount of tonnage it carries very heavy, still its receipts are exceedingly small, and do not yield any return to the owners.

At the bottom of all this trouble lies that barnacle upon railroad prosperity, the fast-freight line. The official to whom we have alluded says: "All the roads running from the East, the great trunk lines, are unfortunately harnessed with too many sub-lines, with which they are compelled by contract to share their earnings. By sub-lines I refer to the lines known as the 'Globe,' 'Blue,' 'Anchor,' 'Star-Union,' 'National-Dispatch,' and a whole grist of others as numerous as the tentacles of Victor Hugo's Devil-Fish." And again: "Each railroad has three or four or more 'lines' hanging to its skirts, which have separate establishments and separate managers, officials, clerks, and runners. They are in themselves, to all intents and purposes, thoroughly organized institutions, and are only secondary to the railroads on whose tracks they run, It costs money to run these lines, but competition has created them and made them appear as a necessity." These parasites upon the railroad system are organized by outside speculators (well grounded suspicion says inside speculators, the wheel within a wheel), who put their own cars upon the tracks, handle them, and do the business as independent of the road as if they owned it, the company meanwhile getting an inconsiderable compensation for the use of engines and tracks. They are about as useful as the parasite, and in their cut-throat competition with each other they play the part of the parasite by sucking away the substance of the road. Their most frequent pretext for existence is that they bring business to the roads, while they do not bring a pound. The business of the country inevitably and of necessity seeks the railroads. There is just so much business to do, and there are no facilities for doing it outside of the railroads. They did it before fast freight lines ever suggested themselves to busy speculators or scheming railroad officials, and they will continue to do it after these barnacles are scraped off, as they must be sooner or later if stockholders ever expect to get dividends. They may divert business from this road to that, but they do not increase the aggregate quantity any more than drummers for dry goods houses increase the quantity of dry goods bought and sold. They are superfluous middle-men, eating up the dollars that legitimately and honestly belong to stock or bondholders, involving the roads in cut-throat competition and bad faith, and eventually bringing some of them under the red flag of the sheriff. They are pirates, who have seized upon the railroad property and hoisted their blue, white, or red flag, as the case may be, and, like the pirate, when they have robbed the ship they scuttle it. Hence all the disorganization and unsettled character of railroad business, the vicious system of rebates, confidential drawbacks, and deadheading, the discovery of directors that there are no profits, though the tonnage may be immense, the orders slashing off 10 or 15 per cent. from the wages of employees, and the unjust and illogical system of switching charges, which it is believed in some quarters do not go to the railroad companies. There are two classes robbed by this middle business,—the stockholders and bondholders on the one hand and the employees on the other,—and meanwhile the general community is not benefited in the least. There is no doubt that the railroad companies can largely increase their profits without cutting the wages of employees at all, by getting rid of these suckers and managing their own transportation, which in these days of telegraph facilities can be done without difficulty. The sooner these fast freight lines are wiped out, whether they are managed by outside speculators or whether they are run by secret collusion of railroad directors, the sooner will stockholders receive dividends and employees good wages.—*Chicago Tribune.*

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Massillon Iron Bridge Co., of Massillon, Ohio, has the contract for an iron highway bridge over the Connecticut river at Sunderland, Mass. The bridge will be 840 feet long, in five spans, and the contract price is $17,692, which does not include the flooring.

The Missouri Valley Bridge Co., of Leavenworth, Kansas, have the contract for, and are engaged in the construction of a number of Pratt Truss combination iron bridges for the Central Branch extension of the Union Pacific R. R. Co., one across the Republican river being 450 feet span.

The new iron bridge on the L. S. & M. S. R. R., at Ashtabula, Ohio, which the Keystone Bridge Co., of Philadelphia, has the contract for building, is to be of the Pratt truss design, and will cost $19,000, not counting the expense of adjusting the parts over the chasm. It is stipulated that the structure shall be in place by September 5.

The Commissioners of Clarke County, Ind., met at Jeffersonville, on the 18th inst., to consult in regard to building a new iron bridge over Fourteen-Mile Creek at Abbot's Crossing. The present bridge has stood the wind and storms of twenty-seven years, and is about played out. The projected bridge will cost about $2,500. It will have to be 160 feet in length.

The first caisson of the new bridge over the Hudson river, at Poughkeepsie, N. Y., which the American Bridge Co., of this city, are constructing, is now resting upon firm foundations 110 feet below high water mark, and the concrete to support the masonry is being rapidly placed in it. A large force of men is at work and the granite abutments on two caissons will be built twenty feet above high water before the ice appears.

The bridge of the new Cincinnati Southern R. R., over the Kentucky river, is said to be the highest railroad bridge in the country. It is 275 feet high, having three spans, the middle one 375 feet long, and the others 300 feet each, the total length being 1,125 feet. There is a bridge in Switzerland which is 254 feet high, but with a span only 144 feet long, and one at Verrugas, in the Andes, 252 feet high, with spans 125 feet long. The piers of this Kentucky bridge are the largest in the country, except those at Brooklyn, the stone work being 130x47 feet and the base of the iron work 117x28. The frame is all wrought iron, and was built out from the abutments toward the centre of each span

The Wrought Iron Bridge Co., of Canton, Ohio, has the contract for building the bridge over the Connecticut river, at Northampton, Mass. The bridge has a total length of 1219 ft. in eight spans with 18 ft. roadway, and will cost about $27,000, exclusive of flooring. This company is also building a 930 ft. bridge in six spans, with 16 ft. roadway, at Columbus Junction, Iowa, being the longest highway bridge in the State, and has the contract for six 120 ft. spans, with 18 ft. roadway, and 5 ft. sidewalk at Paris Ont. They have just completed a 160 ft. bridge, with 30 ft. roadway and two 8ft. walks, on iron piers 25 ft. high, at San Jose, Cal., and are building a 256 ft. span, with 18 ft. roadway, at Preston, W. Virginia; all of the above bridges being on the company's patented truss plans with all wrought iron details. The company have now over 12,000 ft. of bridging in process of construction and are running their works day and night giving employment to over 300 men and are making extensive additions to their shops and machinery to meet their increase of business.

RAILROADS.

The fifty-two railroads of Illinois have 7,275 miles of track.

There is talk of connecting Bellevue and Cascade, Iowa, by a narrow-gauge railroad.

The citizens of Monticello, Napa county, California, are discussing the question of obtaining railroad connection with Napa.

The Colorado Central R. R. was completed to Georgetown, Col., on the 13th inst. Gold and silver spikes were driven with great ceremony.

The engineer employed by the city of Boston estimates the damage to the Boston, Clinton & Fitchburg R. R. by the building of the dams across Sudbury river at $20,000.

Delphos and Kokomo is the name of the company recently organized to build a narrow-gauge road from Delphos, Ohio, a little south of west, to the Indiana line, a distance of 27 miles.

A survey is being made for the proposed railroad from the Hoosac Tunnel, and Petersburg, N. Y., to Albany, and a meeting of the Albany Board of Trade is to be held to hear the results.

A narrow-gauge railroad from Galesburg to Peoria, Ill., is talked of. The length of the road would be forty-five miles—eight miles shorter than the C., B. & Q. branch—and the estimated cost $8,000 per mile.

Articles of association of the State Line & Covington railway have been filed with the Secretary of the State of Indiana. It is the old Cincinnati, Danville & Vincennes road reconstructed. Capital stock $100,000.

During the present year 830 miles of new road has been completed in the United States, against 1,046 miles reported for the corresponding period in 1876, 594 in 1875, 913 in 1874, 1,966 in 1873 and 3,372 in 1872.

The Union Pacific has 170 miles of steel rails, and will this year lay 130 more. Work is being pushed on the seventy-mile branch from Cheyenne to Longmont, which costs $10,000 per mile for the road-bed, and it will be ready for rolling stock by Sept. 15.

A narrow-gauge railroad two feet wide between Billerica and Bedford, Mass., will soon be finished. Its passenger cars, now building at Laconia, N. H. will have a row of single seats on each side. The road is eight miles and a half long, and will cost about $50,000, or less than $6,000 per mile, only one-eighth of the cost of ordinary railroads.

The St. Thomas (Ont.) *Journal* says: "It is expected that the work on the Credit Valley R. R. between Woodstock and Ingersoll will be resumed in a few days. The additional bonus voted by the latter town, together with the substantial aid given by other municipalities, has put the Company on a good financial footing, and it is hoped that the road from Toronto to Ingersoll will be in running order before the end of the year."

Refering to municipal railroad debts an exchange says: "The debt of Cincinnati, is $22,644,000, and of this $17,285,000 has been sunk in aid of the Southern R. R., a dubious enterprise. Baltimore has bonded itself for $9,520,000, but as far as the interest goes the investment has paid. The only other American cities with railroad debts over $2,000,000 are Louisville, which has a railroad debt of $5,000,000, not likely to yield much; Portland, Me., with a very bad one of $4,109,000, and Pittsburgh with one of $2,179,000."

The Cincinnati *Enquirer* of the 16th inst. says: "Colonel McDowel, the President of the Three Forks Railroad, was in the city last week consulting our business men in regard to what aid Cincinnati would furnish to complete the Three Forks Railroad, and was assured by the business men and by the Kentucky Central Railroad that there would be no trouble in obtaining sufficient money to complete the road to the Three Forks of Kentucky River. These promises were made in view that the Kentucky Central would be extended south through Richmond, Ky., a route now being surveyed. It is hardly a matter of doubt that the extension will be made at an early day."

The location of the Minnesota Midland railway (narrow-gauge) under the direction of Chief Engineer John S. Blunt, is being pushed with all possible dispatch. The road is to run from Waubasha, up the valley of the Zumbro river to Zumbrota, a distance of about 53 miles; thence eventually it is to be continued to Faribault. The gauge is three feet; curves are from 2° to 16°, with light grades, there being only about fifty feet rise in 23 miles. The line runs through the finest wheat growing county in the State, and has a local aid of $4,000 per mile. It is intended to push the work to completion as fast as possible, and contracts are ready to be let. Chief Engineer Blunt was in town this week on business connected with the crossing of the Chicago and Pacific and Chicago and Northwestern railroads at Elgin, Ill., of which work he is Commissioner, appointed by the U. S. Court.

At the annual meeting of the Texas & Pacific R. R., held in Philadelphia on the 14th inst., the directors gave a statement of what they ask from Congress. They propose to open a highway, 1,400 miles in length, from Fort Worth to San Diego, which, with the road now completed, shall be under Government control. They will limit the Government's liability to $2,500,000 per annum, for which a first mortage is offered on the road, and 18,000,000 acres of land. Government bonds bearing five per cent. interest are asked at the rate of $35,000 per mile of road constructed. $5,000 per mile to remain in the Treasury of the United States. It is a private enterprise, they say, designed to secure to the people, without cost to the Government, a national highway, the construction of which at this time is believed to be a field for the employment of surplus population.

GAS AND WATER-WORKS.

Monmouth, Ill., is now lighted by gas.

There is very strong opposition to the water works scheme proposed in Peterborough, Ont.

Eleven cities in Brazil are now lighted with gas, while in five more cities it is being introduced.

It is proposed to add Kirk Lake and Lake Mahopac to the Croton, New York city, water supply.

The Joliet, Ill., penitentiary is now being lighted by naptha gas. It is said to make a soft, rich light, at two-thirds the cost of ordinary gas.

The work on the influent pipe at the water works in Covington, Ky., under the supervision of Mr. B. R. Morton, is rapidly progressing.

Voting on the by-law for a system of water works at Wingham, Ont., took place on the 17th inst. The by-law was carried by a majority of twenty-one.

An inventor claims that by using a motor he has invented, at the base of Niagara Falls, sufficient power can be obtained to pump water to Buffalo, and supply that city with the liquid.

A reservoir, to contain 1,100,000 gallons, is in course of construction at the Asylum in Lexington, Ky., and will be completed some time this month. Colonel Thompson, the Chief Engineer, has the matter in hand.

Our Keokuk, Iowa, correspondent under date of the 17th inst., writes us: "The water works question here is, as yet, in abeyance. Everything is waiting upon the requisite amount of subscriptions to stock being taken by our citizens."

New Edinburg, Ont., has made two offers to the City Board of Water Works Commissioners of Ottawa, for fire protection, viz: to pay two hundred dollars per annum for ten hydrants, or pay at the rate of fifty cents per one thousand gallons.

There is said to be a well in Wise county, Texas, one hundred and ten feet deep, which ordinarily has an abundant supply of water at all seasons of the year, but from which, when the wind blows twelve hours from the north, no water can be drawn.

The building now being erected for the *Herald*, in Boston, will be supplied with an electric lighting apparatus, so that it will be unnecessary to use a match anywhere on the premises. This will be the first building of this kind in this country in which the new principle has been applied.

The Liverpool, Eng., Town Council recently discussed a proposal to negotiate with the gas company for the purchase of their works for the Municipality, but the Council would only sanction a preliminary interview. One argument against the proposed acquisition is the probability that gas will be superseded by the electric light to a considerable extent.

The Buffalo, N. Y., water works pump daily from the Niagara river about 11,000 000 gallons, and this supply can be increased at need, with the present engines, to 18,000,000 gallons. The former amount divided among 160,000 inhabitants gives about 69 gallons as the daily consumption for each man, woman and child in the city.

Providence, R. I., seems to be in a fix over the breakdown of its big pumping engine through its being placed over a bed of quicksand. The building still continues to settle, and it is understood that the makers of the engine decline to repair and guarantee it, and one paper calls the $250,000 building and engine "practical wrecks."

The Indianapolis *Journal* of the 18th inst., says:—"Chief Fire Engineer Sherwood, has, in compliance with an order from the Council, ordered the water shut off from 100 fire-plugs located in all parts of the city. The Water Works company claim that this is an act of bad faith on the part of the city and expect to notify the Council on Monday night that the water will be shut off from all the plugs if the city persists in violating the terms of the agreement entered into."

The Committee on Water Supply of Lynn, Mass., at a recent meeting voted to refer the matter of extending the water pipes of the Lynn Works to East Saugus to the Public Water Board who will consider the expediency of the plan and report back to the committee. The present depth of water at the Birch Brook dam is 13 feet 2 inches, and at Breed's Pond 13 feet. It is proposed to raise each of the dams 6 feet, and the City Engineer is now engaged in preparing plans for the same.

MINING.

The antimony mines in Mississippi are yielding well.

The little city of Erie, Pa., last year shipped to various points along the lakes 172,046 tons of bituminous coal, and 60,966 tons of anthracite. This trade is growing rapidly.

About one ton a day is now being turned out of the Dominion of Canada Plumbago Mine at Buckingham. Shipments are being made to New York, Boston, Pittsburgh, Chicago, Philadelphia, Taunton, Mass., and other places.

It is estimated that 20,000 oil wells have thus far been dug in Pennsylvania and West Virginia at an aggregate cost of $192,000,000. They have yielded about 88,000,000 barrels of oil, valued at the wells at $300,000,000, or $400,000,000 at the seaboard.

The quantity of coal raised from the mines of Great Britain reached 100,000,000 tons in a year for the first time in 1866. In 1876 it amounted to 124,125,166 tons—namely, 115,334,359 tons in England and Wales, 18,665,612 tons in Scotland, and 125,195 in Ireland. Durham, the greatest coal-field, keeps its lead, its year's product now approaching 26,000,000 tons. Wales produced above 19,000,000 tons. Nottinghamshire and Cumberland also present a substantial increase. Lancashire, Yorkshire and Staffordshire show a considerable dropping off, as compared with the preceding year; and there is a noticeable decline also in Derbyshire, Northumberland and Leicestershire.

The returns of gold mining in New South Wales for 1876 show that in that colony, as in Victoria, mining is a declining industry. The gold sent to the Sidney mint in 1876 was 73,454 oz below that of the previous year. A more satisfactory account is given of this year's progress in coal mining, the value of the year's output being £1,319,918, or very nearly the same as in 1875, notwithstanding the depression that has been complained of in that industry. The aggregate value of the mineral products of the colony for 1876 was £2,183,095, an amount which, if smaller than the results in former years, still serves to show how large and varied are the mineral resources of New South Wales.

Specimens of silver ore from the Cerro de Pasco silver mines, in Peru, show that the submerged portion of the mountain is very rich, and a rough estimate shows that a body of ore will be exposed, by the new tunnel which Henry Meiggs is to build, worth from $300,000,000 to $500,000,000. These mines have laid under water for fifty years, and are scarcely known to the present generation, though they had been worked for 250 years, when the miners had to stop on account of the water. Peru has now discovered that a tunnel can be built which will drain the mountain completely, by draining off the lake from which the water in the mine comes, and she is so much in earnest about it that the first loads of the new submerged ore are expected to reach Lima in four months. It is predicted that, within ten years, more silver will be taken out than from the silver mines in Nevada.

Reports of newspapers directly interested in the coal trade go to show that there are deposits of real anthracite coal in New Mexico, which needs only that great necesity, capital, to be brought out. A description of the quality of coal taken from a mine in that country is given in the Pottsville, (Pa.) *Journal*: "About 250 tons of coal have been taken from the first mine. It shows all the qualities of a true anthracite, contains 87.5 per cent of fixed carbon, and when burning shows only the short, blue flame of carbonic oxide. The steam boiler of the engine propelling the New Mexico Mining Company's stamp mill has been successfully heated by it. A hundred pounds brought to Santa Fe were used by Mr. Buckner in his assaying furnace, in order to test the heating powers practically. He found that a white heat was reached in a very short time, and that this lasted about three times as long as that produced by an equal weight of charcoal as the material does not choke in the least."

CONTRACTORS.

Mankato, Minn., is talking of a city hall, the building to be three stories high, forty-four by eighty feet, and to cost $8,295.

The Eau Claire Lumber Company have taken a contract for building a boom 1130 feet in length, for the Government, at Rock Island Ill., for the protection of the Government bridge there and insuring the saftey of rafts and boats while passing under it.

The Indianapolis *Journal* of the 18th inst. says: "A huge bill was presented the county commissioners yesterday by Scott & Nicholson, stone contractors, for a balance due them on the court house of $109,288.96. The bill contained the measurement of their stonework, made by Adam Scott, John G. Pendergast and E. J. Hodgson. The bill showed that Scott & Nicholson had received on their contract the sum of $202,557. According to the contract Scott & Nicholson were to receive 85 per cent. on estimates, with half-yearly settlements. The settlements were never made, and the commissioners were somewhat astonished at the magnitude of this balance, as they supposed there was not more than $25,000 behind on this bill. No action was taken on the bill yesterday."

MISCELLANEOUS.

During the year just closed the United States sold 105,000,000 yards of cotton goods abroad, ten times more than was exported the year before.

The reduction of the German tariff on iron the 1st of last January has been attended by a large increase of imports, both of manufactured and raw iron.

The city of Liverpool expends $3,500,000 annually in maintaining and extending its docks, which is more than the entire river and harbor appropriation of the United States.

It is stated that the Committee on streets and the City Engineer of Lafayette, Ind., are in favor of constructing a sewer in that city to cost from $40,000 to $75,000; the idea being to give employment to persons in the city without work, as well as doing good for the city.

Within the the last twelve months there have been extensions made to the various horse railway lines of Chicago, amounting in the aggregate to about twenty miles.

Quite a remarkable discovery has been made near Austin, Texas. A bed of fine hydraulic clay, like that found on the Thames, in England, has been discovered, and a movement to have it worked will be made immediately. This is the material from which the celebrated Portland cement is manufactured.

A Dr. C. W. Siemens, in England, estimates that the falls of the Niagara do as much work in a year as 206,000,000 tons of coal, at the rate of four pounds per horse power in an hour. He considers that the falls might drive an electrical machine, the current of which might traverse a copper rod. He asserts that a rod three inches in diameter would transmit 1,000 horse power as far as thirty miles, and that at the end the electricty could be used to create motion or light. For the latter there would be sufficient to equal 250,000 candles.

Dispatches have been received at Washington from Lieut.-Commander H. H. Garringe, commanding the United States steamer Gettysburg engaged in making a hydrographical survey of the Mediterranean. The vessel was then at Spezzia, having arrived from Constantinople about two weeks ago, and has completed the survey of the Gulf of Lyons, Genoa Bay and Spezzia. for which ports Lieutenant-Commander Garringe sent the manuscript for the sailing directions, for publication by the United States hydrographic office.

Lieut. Lucien N. B. Wyse, U. S. A., has made his report on the Darien Survey in the interest of the Nicaragua Canal project. The gorge or pass of the Tihule is found to be 450 feet above the lowest tides, so that there is no hope of opening a canal without locks or tunnels through a gap between the Cordilleras. A tunnelled canal is also out of the question, and a canal about sixty-five miles in length is proposed, starting at Real de Santa Maria, on the Tuyra, going on above Pinogana and the Cupe river and ascending the high plains and *contreforts* in the Upper Tuyra, crossing it between the mouths of the Pucro and Paca tributaries, and then leading across the Paya through the Cue and Puque valleys, continuing down the Tulegua on the Atlantic slope to the Atrato, avoiding the windings of the Cacarica. The summit of this route is about one hundred and sixty feet high. This route is declared to be better than any surveyed by Commodore Selfridge, and superior in many respects to the Nicaragua line. Lieut. Wyse also suggests a canal without locks, but with a tunnel, the cost of which would not exceed $4,000,000 per mile. This canal should start from the Chuncunaque river, a little way above Yaviza, and then follow in a straight line along the course of the Tupisa river and on across the Cordilleras to the Atlantic at a bend of the coast below Point Gandi.

The canal which the Government has constructed to overcome the obstruction to navigation caused by the Des Moines Rapids in the Mississippi, at Keokuk, Iowa, was formerly opened with suitable ceremonies last Wednesday. The canal extends along the Iowa shore from Keokuk to Nashville, a distance of seven and six-tenths miles, is 300 feet wide in embankment and 250 wide in excavation; minimum depth of water, five feet; maximum depth, eight feet, which is sufficient to float the largest steamers that ply the waters of the upper Mississippi. The embankment enclosing the canal is ten feet in width on top, with a rip-rap covering two feet thick and carried two feet above extreme high water mark. The fall in the entire distance which the canal extends is 1,875 feet. There are two lift-locks and one guard-lock, each 350 feet long and 80 feet wide on top. These are built of solid cut-stone masonry, and are pronounced by experts who have examined them to be very substantial and highly creditable specimens of engineering skill. Sluices of sufficient capacity to control the surplus water carried into the canal by the numerous streams emptying therein during their frequent floods, are built around the locks. These were not included in the original estimate and have materially increased the cost of the work. The machinery for operating the lock-gates and wickets, is made from an original design of Major Amos Stickney, the officer in local charge of the improvement. This plan consists of a system of pullies, chains, and wire ropes, operated by means of a pump forcing the water into hydraulic cylinders sunk behind the walls back of each gate, connected by means of iron pipes, with an engine situated near the head of the lock, so that one man at the engine can handle the massive gates and wickets with ease and precision. The original estimate for this improvement was $3,390,000. It has cost so far $4,281,000. Work was begun on it in October 1867. It is estimated that $100,000 will yet be required to finish the work, and Congress will be asked to make an appropriation of this amount at the next session. The improvement is of incalculable importance to the navigation of the Mississippi river, as it removes the only obstruction now remaining between New Orleans and St. Paul.

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 222.*)

SEC. 3. Board to elect president and treasurer, and make by-laws.

SEC. 4. Majority constitutes quorum; records to be kept of proceedings; copies of all plans, estimates, etc., to be kept; report (annual) to be rendered on or before each year, or when required by city council. Each member authorized to administer legal oaths.

SEC. 5. Board shall have special *charge* and *superintendence*, subject to the laws and ordinances of the city council, of all streets, lanes, alleys, etc., in the city of Chicago, and of all walks and crossings in the same, and of all bridges, docks, wharves, public places, landings, grounds and parks in said city, and of all halls, engine-houses, and other public buildings in the city belonging to city, except school-houses, and of the *erection* of *all* public buildings; of lamps and lights in streets, etc., and in public buildings, and repairs of same; of the harbor works and improvements; of the city sewers and drains and of the water works; of the fire-alarm telegraph, and all public works and improvements hereafter to be commenced by the city, as well as such other duties as may be prescribed by the city council by ordinance.

SEC. 6. All applications or propositions for improvements or new works of kind specified in section five, shall hereafter be first made to Board of Public Works, or if made first to city council, shall be by them referred to Board. Upon receiving application, Board shall investigate the same, and if they find such work necessary and proper, shall thus report to city council, with an estimate of the expense thereof. If they do not approve of such application, they shall report the reasons for their disapproval, and the city council may then in either case, reject said application or order the doing of work or making of public improvement, after having first obtained plans and estimates thereof. The Board may also in like manner recommend whenever they think proper, any improvement of the nature above specified, though no application has been made therefor.

SEC. 7. Shall be duty of Board to procure for city full plans and estimates of contemplated improvements, when so ordered by council.

SEC. 8. Whenever any public improvement shall be ordered by city council, and money appropriated, Board shall advertise for proposals for doing work; plans and specifications of same first placed on file in office of Board, which plans and specifications shall be open to public inspection; advertisement to state work to be done, and to be published ten days at least. The bids shall *be sealed bids*, directed to board, and accompanied by bond to city, signed by bidder and two responsible sureties, in sum of two hundred dollars, conditioned he shall do work if awarded to him; in case of his default to do so, etc. Bids to be opened at time and place mentioned in advertisement.

SEC. 9. All contracts shall be awarded to lowest reliable bidder, and who sufficiently guarantees to do work under superintendence and to satisfaction of Board: *provided*, that the contract price does not exceed the estimate, or such other sum as shall be satisfactory to Board. Copies of contracts to be filed with city comptroller.

SEC. 10. Board reserves right, in contracts, to decide questions as to proper performance of work and meaning of contracts; in case of improper construction may suspend work and relet same, or order entire reconstruction; or may relet to other contractors and settle for work done, etc.

In cases where contractor properly does work, Board may, in their discretion, as work progresses, grant to said contractor estimate of amount already earned, reserving fifteen per cent. therefrom, which shall entitle holder to receive amount, all other conditions being satisfied.

SEC. 11. In case prosecution of any public work be suspended, or bid be deemed excessive, or bidders be not responsible, Board may, with written approval of treasurer, where urgency of case and interests of city require it, employ workmen to perform or complete any improvement ordered by council: *provided*, that the cost and expense shall in no case exceed the amount appropriated for the same.

SEC. 12. All supplies of materials etc., when costing over five hundred dollars, to be purchased by contract, subject to same conditions as letting out work.

SEC. 13. Whenever Board think necessary for interests of city, to protect same from damage or loss, shall report thus to aldermen, and reasons for same, asking power to give contracts without notice required above, and aldermen may grant request: *provided*, three-fourths vote for it.

SEC. 14. Whenever Board is of opinion work may be better done without contract, shall so report to council, and same may authorize Board to procure machinery, materials, etc., hire workmen, etc.: *provided*, a three-fourths vote be in favor of granting authority.

SEC. 15. All contracts and bonds by Board to be in name of city.

SEC. 16. No member to be interested in any contract; all contracts made with any member interested, city may declare void; any member so interested shall forfeit his office and be removed therefrom; the duty of every member of Board and of every officer of city to report delinquency, if discovered.

SEC. 17. All existing contracts executed by city, by water or sewerage department, etc., to be carried out by Board.

SEC. 18. Board shall nominate each year the various officers, now provided for by ordinance, which serve in the departments under their special charge, the city engineer, superintendent sewers, streets, etc. Shall be empowered to employ from time to time such other superintendents, clerks, etc., as they may deem necessary, subject to ordinance as regards pay, etc.

SEC. 19. Board to have charge and superintendence of works made for city, and paid for by private individuals or by State. Plans for same to be approved by Board.

SEC. 20. Board shall, on or before every year, submit to auditor, by him to be presented to council with annual estimate, statement of the repairs and improvements necessary to be undertaken for current year, and of the sums required by Board therefor; report to be in detail; report, having been revised by council, sums required shall be provided for in annual tax levy. All moneys to be paid to any person out of moneys so raised, shall be certified by president of Board to auditor, who shall draw warrant on treasurer therefor, stating to whom payable and to what fund chargeable; such warrant to be countersigned by president of Board.

SEC. 21. Board to keep accounts showing moneys received and spent, clearly and distinctly, and for what purpose. Accounts to be always open for inspection of auditor or any committee appointed by city council.

The object of introducing this synopsis here has been to give a complete picture of just what such a Board of Public Works is. It will be seen upon a little examination how entirely different a thing it is from the usual and only too customary "committee." Perhaps the greatest fault of a committee is its entire lack of what might be called body *and* soul. If corporations, as has been said, have no souls, a committee may be said to have neither body nor soul. It is alive to-day, wields great power, decides vital and important questions, and yet is nowhere to-morrow, and seemingly even its component atoms have vanished from the face of the earth. It is amusing and yet sad, when the action of some such

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

committee has caused trouble to read some time after, that it all "is exceedingly discreditable to whoever is responsible for it." How much better to have a conservative, expert and reliable body, the members of which have *no other business* than to attend to their duties as such, who are well paid for it and consequently can at any time be held strictly responsible for their actions. With such a power, wisely governing and regulating the roads of this Commonwealth, it would be an easy matter to make thorough improvements in the legislation concerning roads and in the roads themselves.

These are two changes the need of which is generally felt at present and has found expression in various ways.

It may be well to quote one at least, notable for saying very much in little compass,—of these calls for improvement, in this connection, and adding some more as belonging to this subject in the form of an interesting appendix. Says Gov. Claflin in his Inaugural: "Few things are of greater importance to a community, or a surer test of civilization, than good roads. Those of our citizens who have visited Europe are unanimous in the opinion that our public roads are far inferior to those of other countries, where the means of easy and safe communication are better appreciated. The science of road-making is apparently not well understood; or, if it is, the present modes of superintending the construction and repair of roads are so defective that the public suffers to an extent of which few of us are aware. It may be found upon investigating the cause of our miserably poor and ill-constructed roads, that the laws relating to this subject need revision, so as to give more uniformity in their construction and the repair of our highways. It is evident, also, that the science of road-making should have a prominent place in the course of applied mathematics at the Massachusetts Agricultural College."

We stand then in this matter of roads at precisely the same point that the good people of London did ten or a dozen years ago in the matter of their drainage, and our remedy is the same. The fault lies in the machinery of government; originally built up to cater to the wants and needs of a newly settled country,—a colony breaking a path through the wilderness,—it has long since ceased to satisfy the demands of the present *State* in no matter so essentially as in that of its government and laws relating to common roads and highways. This is a subject requiring special knowledge, to be acquired only by long experience or the shorter method of imbibing the experience of others, which, on analyzing it, is all that any *study* amounts to; formerly it was not so, and most any one sufficed to make improvements on Indian paths. We need then an *expert* government on this point.

There should be a distinction made between first, second and third class, or between, as they might be called, State, County and Town roads; the first two should not be left to be dealt with as it is the pleasure of each town. A chain cannot be perfect unless every link in it is so; no more can a road. The State must attend to the State and County roads and set a proper example at least to be followed by the towns in the case of their roads. We need then a higher power than that of the towns.

It has been previously shown how we need a power that can be held responsible and is somewhat permanent, and to put it all together, we need, to order and maintain our highways, a Massachusetts Board of Public Works. For some years it would have its hands full in improving the existing main roads and laying out some new ones, but in course of time, as in the older countries of Europe, its principal business would be the *maintenance* of the roads. It must be remembered that the Board of Public Works is merely the intelligent servant and adviser of the legislative and executive; whatever sums the legislature appropriates for certain objects, that is taken by the Board and made to yield its most in the shape of work accomplished. Beyond this and keeping its accounts, it has nothing to do with money or taxation.

The small state of Baden, a part of Germany, has been heretofore mentioned as a model in road construction and the care of the same. From a brief history of the roads of that country and their present management, we may take some useful notes. The account is that of the Chief Engineer of the department of "Roads and Hydraulic Engineering," which has this matter in charge and is therefore reliable.

"In Baden the condition of the roads has been a subject of great care. Within the last forty-five years many millions have been spent upon them, and experience has shown this expenditure to be one of those most advantageously spent. As most of the roads are well laid out, and as there are plenty of them, there remains now (1863) mainly the keeping in repair of the roads to be attended to and not to build any new ones. Our endeavor now is, to do this at the minimum of cost. Statistics gathered on this subject, show good results and point out to us the means of arriving at still better ones. The present road law was made in 1810. That part of the old law which relates to the maintenance of roads is still in force, but that part requiring labor as a road-tax was abolished in 1831, and likewise most of the road police regulations. The appropriation for roads had to be increased 250,000 florins to pay for the abolished road-tax labor and to make up 170,000 florins previously received from tolls, which were also abolished in 1831. The system now is as follows: All town roads are taken care of by the towns. The State merely appoints and pays a road-master, so called, who superintends fifteen or twenty road-keepers and reports on the state of the roads, the reasons for their bad condition, if that be the case, what is needed, etc. The law for second class or county roads was formerly, that when they were of importance to several towns, they had all to help maintain the same. As this gave rise to continual bickering and quarreling, in which the road suffered most, it was changed in 1856. They are now taken care of under the direction of the State and paid for partly by the State and partly by the towns in which they are situated. Most of the roads under this head are those which have risen in importance since the building of railroads, and are generally those that lie perpendicular to the direction of the railroad they are influenced by. The towns not having the means very often to properly improve and repair such, it was found necessary and expedient to give them the aid of the State, and in order to procure the necessary funds, all roads that run parallel to railroads and all those that had lost their importance by the construction of railroads, were in 1855 stricken from the list of state roads. These latter as the name implies, are wholly under the care and kept up at the expense of the State.

In 1835, the total length of the State roads was . .	1,430.8	English miles.
In 1855, " " " " . .	1,500.8	"
In 1855, by excluding several State roads, this last length was reduced to	1,142.4	"
In 1861, it had increased to	1,190.0	"

Second class Roads (keeping partly paid for by State.)

In 1835, the length of these was	467.6	English miles.
In 1861, " "	630.0	"

The areas, population, and population per square mile of Baden, Prussia, France, Hanover and Massachusetts, according to recent census, are as follows:

Country.	Year.	Area, sq. miles.	Population.	Pop. per sq. mile.
Baden.	1871.	5,891.	1,461,562.	248.
Prussia.	1871.	134,045.	14,643,698.	184.
France.	1872.	204,088.	36,102,921.	177.
Hanover.	1871.	14,857.	1,963,080.	132.
Massachusetts.	1875.	7,800.	1,651,912.	212.

Baden did have, at a time when her population per square mile was less than it is now, and Prussia, France, Hanover, and many other countries that could be named, have now got, and for the past 40 or 50 years have had, a system of common road management and resultant common roads, of the character above described; while Massachusetts with a population of 212. per square mile, and corresponding wealth, and others of the States of the Union, have a species of highway management, and *its* resultant and corresponding sort of highways, which, in thinking of the roads of the countries named, are but as evidences of a partial civilization.

(To be continued.)

OUR RAILROADS AND THEIR ECONOMICAL USE.

III.

The first iron rails were made of much better material than is used in their manufacture at the present time, and rails are now in service which were rolled in 1835, and have been in constant use ever since. But as the demand increased, an inferior article was made, and the increase in weight of rolling stock soon destroyed these, not by wearing them out, but by crushing them, or separating the imperfectly welded parts of the rail pile.

To overcome in some measure this defect, and to produce a rail that would sustain the traffic, the rail head was made of phosphorus bearing iron, which being harder than any previously used, did seem at first to be an improvement. The old rails were then re-rolled, new material being added to the top and bottom of the rail, but successive re-rolling soon incorporated the phosphorus through the entire mixture, rendering the rail very brittle. The writer has seen many miles of such rails which did not sustain the traffic of fifty trains per day for three months, and a year was a long time for them to last. Now, these rails being made from the old ones could be sold for much less money than a better article, and to the average railroad manager cheapness was their chief merit; it was quantity not quality that he was after, and if he could buy a large quantity for one or two dollars less than the market price, he was entitled to corresponding credit as an able financier, and corresponding emoluments of course.

The natural consequence of all this actually was, that the iron manufacturers grew rich, and their success led men who were ignorant of the first process in the business of iron smelting, and who knew nothing whatever of the wants of the trade or the demands of the times, to embark their capital in the mining or manufacture of the sovereign metal. As in most of industries where the demand exceeds the supply, but little attention was paid to improved processes of manufacture, but everything was carried on in a crude style and with corresponding expense.

The war having changed the course of commerce, our great trunk lines had a rapid increase of business which yielded good and quick returns; new competing lines were built; nearly all the Western States had extensive land grants, and by 1865, railroad building had received an impetus, that was felt far beyond our own shores in supplying the necessary materials and funds. Lines were projected and built without any consideration of the real wants of business, and we may fairly say, that we entered into a period of *railway speculation*. Blast Furnaces, Rolling Mills, Locomotive and Car Shops, Wheel Foundries, and Forges sprung up all over the land to meet the demands for supplies for railroad construction. The most sagacious railroad managers were looking for some better material for rails than the inferior, and almost worthless iron rails of the times, and were ready to appreciate Bessemer steel. In 1863 some rails were imported and found so good that more soon followed, and Bessemer steel plant was soon introduced into this country. The trunk lines were laid with steel, and the demand for iron rails rapidly lessened except for the construction of new lines.

All material was high, labor was dear, and air lines were constructed at fancy prices. Large bonded debts were assumed and great rates of interest promised. The increased returns of Eastern roads in a more thickly populated country, largely engaged in manufactures, was considered sufficient guarantee that those of the West would pay. People were clamoring for cheaper transportation, and competing lines were built between the same points, in order to lessen the rates. The projectors of lines who were promised large volumes of business as soon as their lines were completed found these promises broken, and they could only get business at competing points at rates for transportation far below the actual cost of conducting the business.

From 1860 to 1865 we find that the progress of railway building has some connection with the increase of the debt of the United States, but it received such an impetus that it did not stop with its increase for some years. The debt in July 1st of each year from 1860 to 1870 is here given.

1860	$ 64,842,287.88
1861	90,580,873.72
1862	524,176,412.13
1863	1,119,772,138.63
1864	1,815,784,370.57
1865	2,680,647,869.74
1866	2,773,236,173.69*
1867	2,678,126,103.87
1868	2,611,687,851.19
1869	2,588,452,213.94
1870	2,480,672,427.81

* Maximum.

The majority of the supplies for the war were furnished by our own country, and from the inflated values, greater volumes of currency were in circulation, than had been in the slower growths of the country. Capital sought investments in anything that was supposed to yield returns; hence the rapid railway extension and its consequent manufactures.

According to the census of 1870, the wealth of the United States and Territories returned for taxation purposes was as follows:—

States.	Real and Personal Estate.	Sq. mi.
Alabama	$ 201,855,841	50,722
Arkansas	156,394,691	52,198
California	638,767,017	183,194
Connecticut	774,631,524	4,750
Delaware	97,180,833	2,120
Florida	44,163,655	59,268
Georgia	268,169,207	58,000
Illinois	2,121,680,579	55,410
Indiana	1,268,180,543	33,839
Iowa	717,644,750	55,045
Kansas	188,892,014	81,318
Kentucky	604,318,552	37,680
Louisiana	323,125,666	41,346
Maine	348,155,671	35,000
Maryland	643,748,976	10,188
Massachusetts	2,132,148,741	7,800
Michigan	719,208,418	56,451
Minnesota	228,909,590	83,531
Mississippi	209,197,345	47,156
Missouri	1,284,022,897	65,350
Nebraska	69,277,483	70,469
Nevada	31,134,012	104,592
New Hampshire	252,624,112	9,280
New Jersey	940,976,064	8,320
New York	6,500,841,264	47,000
North Carolina	260,757,244	50,704
Ohio	2,235,430,300	39,964
Oregon	51,558,932	95,274
Pennsylvania	3,808,340,112	46,000
Rhode Island	296,965,646	1,306
South Carolina	208,146,989	34,000
Tennessee	498,237,724	45,600
Texas	159,052,542	274,356
Vermont	142,612,356	10,212
Virginia	409,588,133	38,348
West Virginia	190,651,491	23,000
Wisconsin	702,307,329	53,924
Total States	$29,729,797,943.	2,053,415

Territories.	Real and Personal Estate.	Sq. mi.
Arizona	3,440,761	113,716
Colorado	20,243,303	104,500
Dakota	5,599,752	150,932
District of Columbia	126,873,618	60
Idaho	6,552,681	86,294
Montana	15,184,522	143,776
New Mexico	31,349,793	121,201
Utah	16,159,995	84,633
Washington	13,562,164	69,994
Wyoming	7,016,748	97,883
Total Territories	$245,983,367	972,989
Total States	$29,729,797,943	3,026,404
Total	$29,975,781,310	

ON THE FAILURE OF THE ASHTABULA BRIDGE.*

(*Continued from page 226.*)

If the views I have expressed have any foundation in fact, the question of the effect of frequently-repeated breaking up of trains on under-grade bridges certainly deserves more attention from engineers than it appears to have received hitherto.

Mr. Thomas C. Clarke.—Most of the arguments in favor of bridge inspection proceed upon the supposition that railway bridges alone need it; some think that the railway officers themselves can be trusted to do this, while others think inspection should be placed in the hands of independent persons.

The truth is that railway bridges are, as a whole, much more carefully looked after, and are far safer than highway bridges. Inspection, to be valuable, ought to be general, and cover all kinds of bridges. Mr. Macdonald's *reductio ad absurdum* argument, would abolish boiler inspection and every other kind of inspection now in use, which, feeble as it is, is better than nothing.

But the most important requisite in my opinion, is that inspection of bridges should be made according to an uniform system. As it is now, the State Legislatures under the spur of the panic derived from the Ashtabula disaster, are passing laws providing for inspection under different systems, and with different penalties. The enforcement of these laws will be placed in the hands of men of very varying qualities.

I should much prefer to rely on Mr. Garfield's bill, if it contained an additional provision, that his Board should first of all, meet and take evidence from engineers particularly those expert in iron bridge construction and establish upon the basis of that evidence, certain general rules to apply to all bridges, both railway and highway; such as, *first*,—the least load to be provided for, on different lengths of spans, and on parts of the same span; *second*,—the margin of safety; *third*—the mode of connecting the parts together, so as to form a whole as strong as those parts, and *fourth*,—such mode of construction as would best prevent deterioration and decay.

All of this I believe could be expressed in such words as would, while not fettering the skill of designers, yet would increase the safety of the public. These rules should be published and communicated to the different authorities, state, municipal and railway. As to what action should be taken after that, in regard to penalties, etc., not being a lawyer, I shall say nothing.

As an engineer, however, I wish to record my opinion, that inspection should be in the hands of independent parties, should cover all kinds of bridges, and should be under one uniform system, based upon evidence taken from experts in bridge construction.

Mr. Robert Briggs.—In common with most engineers, I have taken a lively interest in the inquiry into causes of failure of the Ashtabula bridge. I wish to call attention to some considerations which ought to be stated, and possibly should have a mathematical investigation.

The inquiry of strength, so far as Mr. Macdonald's paper is concerned, is confined to the truss strength to carry vertical loads, but as suggested by Mr. Philbrick, the deflection of the floor beams would render the load far from vertical; and it seems to me that a full discussion of the strength and deflection of these floor beams, and the effect of the strain, from this deflection or effort upon the upper chords, could be computed with much accuracy. No mention is made of the condition of the floor beams after the accident, and the presumption is that they were found to be unharmed and straight, but it is difficult to conceive of a floor of 6-inch deep beams, spaced 3 feet 8 inches from centre to centre, as suitable to carry the rolling load of a train and 2 engines, besides the floor load. Mr. Macdonald gave the floor beams, 6 inches deep with 4-inch flanges and 9.6 inches section, which gives 0.785 as average thickness of the beams, web and flange. A rough computation, where I do not want accurate data of exact place of application of load and of weight of floor, would give the loads on these floor beams very close upon the limit of permanent elasticity, and would throw more than double the compression strain on the inner struts and chords of the truss. If it could be shown that the beams, at or near the place of apparent failure of the truss were sprung, the probablity of the failure having proceeded from the *rocking* of the wide upper chord lines might be asserted; without such evidence, it may be assumed, the effort of deflection must have produced, as Mr. Philbrick says, "a transverse strain on the two inside members of the top chord," and besides this, a severe excess of load and diagonal strain on the inside members of the struts.

The application of Gordon's fomula to these sections is scarcely a fair one. This formula is in strictness only applicable to sections symmetrical in at least three directions. Given, a strut 6 × 4 inches, it will evidently not fail under compression in the 6-inch direction, so that any theory of failure of the bridge founded upon this formula, is manifestly at fault as a theory, and the lesson of this accident is, that we should construct columns to which Gordon's formula will apply, or whenever the design involves an unsymmetrical column, we should stiffen it in the weak direction.

It is perfectly safe to construct iron bridges *without*

* Discussion by the American Society of Civil Engineers.

cast iron bearing pieces, and to use pin joints, for struts as well as ties. The same safety, applies to making available all the stiffness attainable in the tension members, and I am very certain that economy of construction can be made to accompany prudence or safety if these latter are required independent of management or contractors' interests, by government inspection.

Upon the further question of Congressional action on the subject of railway construction or traffic, I wish to say, there can be no question as to the desirability of a government inspection for the protection of travelers on railroads—I should prefer the English word, railways—and this inspection should have power to enforce results through the courts of the United States, by suspending traffic, or otherwise, as the court should direct.

The alternative ways of protecting the public are:

First.—Those of legal requirements obliging owners or directors to have inspections made previous to occupancy or use and at stated intervals of time afterwards, by their own officers or employees. This method would fail, as is evidenced by the Ashtabula accident, because, however competent or careful such officers or employees may be, their inspections would be biased in favor of the employers' interests as a matter of economy or profit. Strictures upon, or condemnation of, a bridge or piece of road bed would probably result in prompt dismissal of the offending engineer, as it did for Mr. Tomlinson in the Ashtabula case.

Second.—In popular estimation, the *insurance* method, either of the bridges or of the indivduals. The railway companies or the traveling community are to be insured against accident. The policy of this proposition can be discerned by the statement that the value of the insurance to the insurers, not to the insured, lies in the proportion of the risk. It would be for the interest of the insurance companies or agents to accept anything proposed, over which a train could be run at all, rather than to examine or test for themselves at a greater expense than the small per centage to risk. In fact, the railway company and travelers insure themselves now, with very little loss of property or life. Still these accidents are preventable, certainly in some further degree than has yet been accomplished, and it becomes a great public duty to take measures to this end, and another way should be considered.

Third.—The protection of the person and property of the traveller or of goods in transit is one of the prime functions of government, and on the establishment of our Federal Union, this duty was devolved by the Constitution upon a general government, not merely in permission, but as an obligation. Under this constitutional provision, Congress has passed laws relative to steam vessels, and established a Board of Inspectors with very ample power and authority. The results of this legislation have been evidently satisfactory in the prevention of disasters, which previously were of frequent occurrence.

The saving to the steamboat owners, if it be assumed that boiler explosions would have, without this inspection, happened as often as before the law, has been much greater in money value than the cost of inspection for any year under the law, while the public has gained almost perfect immunity from accident, except from criminal carelessness.

It is not to be supposed that the railway companies will favor any "interference." The mild proposition to establish a Board of Undertakers suggested in the bill of Mr. Garfield, will fail to meet the views of those who only wish to be let alone. I doubt if the public will be satisfied even if the military engineers who are assigned to this duty, prepare obituary notices of the unfortunate deceased passengers.

I do not question that from amongst the able educated men who constitute the corps of U.S. Engineers there will be found three members who will not only be capable but emulous to organise a Commission on Railway Traffic and Construction, even under the dubious authority of the bill "to provide for the more thorough investigation of accidents on railroads," but their number will prevent any useful result, and their authority, or want of authority, will make the Commission almost a laughing stock. We do, the nation does want a supervision of the railways for the safety of passengers and the prevention of accidents. A Board of Commissioners of eminent civil engineers, appointed for districts like the steamboat inspectors, would evolve in a few years such rules and regulations as would meet fully the exigencies of the case. The present moment is an admirable one for commencing such a Board. Public opinion is fully awake to its necessity, and only calls for direction in the right path to insure both public and legislative success. With this conviction, I would suggest that one of the steps most evidently proper, is the expression of opinion of our Society, as a society, upon the subject, to be used before Congress at the coming extra session. I think some members of the proper committee of the House or Senate will gladly take up the question, if it be offered in a practical form from the American Society of Civil Engineers.

Mr. Theodore Cooper.—I am glad to find that Mr. Macdonald reports the material of this bridge, as of a good character, for had it been of poor quality there would be greater difficulty to make those who have charge of iron bridges believe that there can be any other reasons for iron bridges failing.

I would class the "ills that bridges are heir to" under the following general heads:—the material; the design; the manufacture of the parts; the erection or assembling together of the parts, and finally, the general neglect or abuse they afterwards receive from the hands of those who have the immediate care of them.

1°.—The Material—The necessity for employment of good material is more fully appreciated, I think, than the other points in reference to which the bridge may be weak—and certainly far more stress has been paid to this part of the subject.

2°.—The Design—By faults of design I would not only include those due to general form or style of bridge and improper determinations of the strain sheet but those which might more properly be classed as faults of guesswork. In too many of our built structures, it would be found, that the so-called minor details of them have been proportioned in this manner. To illustrate, I could point out two sets of plate girders of exactly the same general proportions, and carrying the same load, in which the rivets have been spaced by guesswork in one and by a determination of the "strains transferred" in the other. The web sheet in the first, has a strain in each rivet hole at the ends of the girder equal to 40,000 pounds to the square inch; while in the other, the strain upon even the rivet holes is less than 12,000 pounds per square inch. Now the former case is a very frequent one. Do not understand, that such faults are confined to riveted work, for were it necessary to multiply illustrations, I could show similar neglect in bridges with pin joints. Now to a superficial examination, the above girders are of equal strength, and should one set fail and not the other, the explanation would undoubtedly be sought in the "crystallization of the metal," or some other equally mysterious reason, instead of laying the fault to guesswork designing.

(*To be Continued*).

RAILROAD WAGES.

In consequence of their embarrassed financial condition many of the railroad companies have reduced by ten per cent. the wages of their employees, and this reduction, it is alleged in some quarters, is a tyrannical and inhuman act, which has no complete justification in either economics or morals. In examining, as we now purpose doing, the correctness of this allegation, we shall have nothing to say about the recklessness of railroad management, swindling directors, and autocratic presidents. About these things we have already expressed decided opinions, and shall, without doubt, have occasion to refer to them again; but the wages of employees are not dependent upon the blunders or misconduct of their employees, and we have been sorry to observe respectable newspapers recently half-apologizing to the strikers whom they opposed, because of the assumed immoralities of railroad managers. We do not care to consider any argument in justification of the late reduction which would not be equally good were railroad companies universally made up either of knaves or angels.

Hitherto railroad employees have been content with their wages. No one pretends that they have been unfairly proportioned to the wages of other American workmen, and we have all listened to the triumphant terms in which these have been compared with the wages of workmen of other countries. It is fair to assume, therefore, that until a very late date engineers, firemen, and brakemen were unable to complain of the equitableness of their wages. But precise figures and a good starting-point are furnished us by Mr. Arthur, chief of the Brotherhood of Locomotive Engineers, in a recent communication to the *Herald*. Twenty years ago, says Mr. Arthur, engineers' wages were $60 and firemen's $30 per month, conductors' from $40 to $60, and brakemen's $30. He admits also that the present pay of all these classes is now, since the reduction, equal to what it was then, but asserts that the cost of living is twice as much now as then. There was no great fault found with the wages of railroad hands prior to the civil war. Mr. Arthur's first statement may be accepted as substantially correct. There was probably more variation in the wages of railroad hands then than now. Firemen and brakemen certainly received less than $30 per month on some roads twenty years ago, and some engineers received more than $60, but the average must have been very nearly as above stated.

It is not necessary for us to repeat here any of the long lists of figures with which the papers have been filled giving the wages of the different classes of employees on different roads, and comparing them with the wages received in other years. It is sufficient for our purpose to state that, taking the average of wages actually paid by a large number of roads, railroad engineers are now receiving $85 per month, firemen $45, and brakemen more than $42—in many instances more than firemen. Of course the varations from these averages are considerable, but, so far as we have been able to ascertain, no engineer receives less than $60, and no fireman or brakeman less than $30—that is, as regular pay for full time—while some engineers receive as high as $115, and some firemen over $58. Not only, therefore, do these three classes of employees receive as much as in 1860, but engineers average 41⅔ per cent. more, brakemen 39½ per cent. more, and firemen 50 per cent. more.

It should be remembered, moreover, that the wages of railroad hands have never been very much higher than at present. When the cost of living was greatly in excess of today's cost, the wages of firemen and brakemen, although larger than now, were not proportionately larger. There has been no reduction, save the present one of ten per cent., on the Pennsylvania road; for instance, since 1873; and Donahue, a leader of the strikers on the Erie road, employed there for more than twenty-five years, refers in a published letter of grievances, to only one 10 per cent. reduction since the war. Putting together all the roads concerning which we have been able to obtain statistics, wages of the classes mentioned are nowhere much more than 20 per cent. below the highest point reached; 25 per cent would be an extremely liberal allowance, but even this would be considerably below the average reduction in other and corresponding pursuits. To get some idea of the movements of wages, take those of carpenters from 1860 to the present time. One of the most prominent carpenters and builders of this city was paying in the spring and summer of 1860, to first-class workmen, $2 per day of 10 hours' work. In the autumn his men struck for $2 25 per day, and got it. In 1861, at the outbreak of the war, wages went all to pieces, and for a time no regular rates were established anywhere. They soon reached the last figures mentioned, however, and then rose rapidly until on the 1st day of May, 1872, the same man agreed to pay the same class of workmen $4 per day of only eight hours' work. This agreement lasted two years. Then wages began to decline, and today the men in the same shop are receiving $2 50 per day of ten hours' work, although in other shops the same class of workmen are paid but $2 25. Carpenters wages, therefore, have fallen from the highest point reached from 37½ to 43¾ per cent. in actual wages paid, or, if the difference in the length of a day's work be taken into account, no less than 55 per cent. The wages of plasterers and masons have fallen still more. The highest point reached by them was $5 50 and $6 per day; the present price being $2, or, in some cases, $2.50—a fall of from 54½ to 66⅔ per cent. The most rapid rise in wages perhaps was that of first-class tai-

lors, which, from 1863 to 1873, went up nearly 132 per cent., from which they have as yet declined not much more than 20 per cent., the hold of a powerful trade-union by which they were forced up and kept up having only recently been broken. The wages of common laborers have declined from 37½ to 50 per cent., and of other laborers in special pursuits but not necessarily skilled workmen (blacksmiths' helpers, etc.), from 37½ to 60 per cent. These facts are enough to illustrate the truth that the wages of firemen and brakemen upon railroads have not fallen relatively as much as the wages of the great body of workingmen of all classes throughout the country, and this statement we believe to be indisputable even after all allowances have been made for special cases of hardships and underpayment. Whatever real cause of complaint, therefore, railroad hands may now have with regard to the amount of their wages, the great body of mechanics and laborers, who have had no serious thoughts of striking, should have far greater cause.

The comparative necessary cost of living in different years can only be ascertained approximately because of the great number of articles and fluctuations in prices to be considered. Rents of city mechanics have not as yet fallen from the highest point reached in proportion to wages. From ten to twenty per cent. would probably cover the average reduction in this class of tenements; but, on the other hand, the rents of railroad employees were probably never so high in proportion to wages as those of city mechanics. The cost of clothing, again, cannot be accurately compared, because the domestic stuffs of which common clothing was made in 1860 are not now manufactured. The fall in the price of the cheaper grades of goods, however, within the past three years has been very great, fully equalling the fall in wages, and bringing the price of a suit of clothes very close to that paid in 1860. Of other necessary articles of household expenditure, coal and oil are very much cheaper than in 1872–3, or even 1860, flour is cheaper than in 1873, vegetables are perhaps about the same as in 1860, and meat and butter are somewhat dearer. On the whole, we believe that the figures given recently in an article in the *Tribune* may be accepted as trustworthy. The average of prices of over sixty different articles of household expenditure is found to be less than seven per cent. above that of 1860. In other words an engineer receiving $60 per month in 1860 should receive today, if wages were governed solely by cost of living, about $64 per month. As a matter of fact, he receives, as we have already ascertained no less than $85 per month.

We do not pretend to determine the amount per day upon which a workingman can live. It is well to remember, however, that not only all common laborers, but great numbers of workingmen at least as skilled in their pursuits as firemen and brakemen, are now living uncomplainingly upon far less than the wages paid to these. The striking miners in Pennsylvania have been receiving from $15 to $20 per month only, and assert that if their demand for 25 per cent, advance be complied with they are willing, if necessary, to work only a portion of the time, with, of course, a corresponding reduction in the amount of wages. Firemen and brakemen are not skilled mechanics. They are but a grade above common laborers. Their places, indeed, might readily be filled from among these. Their wages, therefore, can never be very high. That they can readily live upon the wages now received has already been proved by past experience. Their recent intense expression of dissatisfaction arose not from any clear understanding of the relative amount of wages received, but from the great difficulty which all unthinking persons have in consenting to the sacrifice of anything to which they have been for a time accustomed. No one, however intelligent, finds this process a pleasant one; but the ignorant man turns brute-like upon the hand that seems to be wilfully depriving him of his coveted goods. That the railroad companies are doing all that they might, even from interested motives, for the welfare of their employees our readers well know we do not believe; but they are paying the firemen or brakemen all that he is economically worth. Less than this he can never receive for any great length of time. A demand for more than this, accompanied, with violence, can, in defence of the existence of society, only be met with violence.—*The Nation.*

SPECIFICATIONS FOR LEVEE.

1. *Graduation.* Under this head will be included all excavations and embankments required for the formation of the levee; cutting all ditches or drains about or contiguous to the Levee; the excavations and embankments necessary for reconstructing public roads and passways, in cases where they are destroyed or interfered with by the construction of the levee, and all other excavations and embankments connected with or incident to the construction of the levee; the grubbing and clearing of all timber and other vegetable matter within the levee way; and the felling of all trees within 100 feet of the center line of the levee.

2. All cuttings other than borrowing for embankment, shall be measured in excavation and estimated by the cubic yard and paid for as earth.

3. The levee will be graded 8 feet wide on top, except where otherwise directed by the chief engineer, with side slopes of such inclination as the chief engineer in each case shall designate, and in conformity to such heights of filling as may have been or may hereafter be determined upon by the chief engineer. Material for the levee shall not be procured within a less distance from the front slope stakes than 20 feet.

4. The ground to be occupied by the levee must first be cleared of trees, stumps, logs, trash, weeds, and all perishable matter; the trees and stumps being cut level with the surface of the ground. The entire surface must then be thoroughly broken with a spade or plow, in order to form a bond with the earth deposited. Then a muck ditch must be cut 6 feet wide at top, and 2 feet at bottom, and 4 feet deep; all stumps and roots crossing it being carefully taken out and removed beyond the base of the levee. The muck ditch must be cut 10 feet from the centre line of the levee on that side next to the river, (great care being taken not to displace any of the stakes of the center line.) As each section of a mile in length, or the entire levee is thus cleared, broken and muck ditch cut, the contractor must notify the engineer of the fact, when he will measure the contents of the ditch and the area of the surface broken, and then set stakes each side of the center at the proper distance for the base of the levee. But in no case will these stakes be set till the clearing, surface-breaking and muck ditch are done as above described, one and ¼ mile in advance of the embankment, and no embankment put up without this previous preparation, or before the side stakes are set, will be estimated or paid for. As soon as the work is staked the muck ditch must be filled in again, with buckshot earth or clay obtained from without the base of the levee, and the earth tamped in by horses or mules, ridden rapidly back and forward constantly while the earth is being put in, or by tamping mauls; at least one horse to every ten wheelbarrows being thus employed; or one tamping maul to six barrows. This filling and tamping to be kept one-fourth mile in advance of the embankment. In case of repair of old levee all stumps, logs and trees, where they are known to exist, must be dug out, and the muck ditch cut near the outside base of old levee, unless the engineer in charge shall ascertain it to be unnecessary from its previous mode of construction. The surface of all old levees must be well broken. In case where the chief constituent of the levee is sand, or other porous material, the chief engineer may require a wall of buckshot or clay, five feet thick, to be continued up from the muck ditch to the top of the levee, the earth being tamped in by horses in the same manner as the muck ditch, as the levee is built up on each side of it, the object being to obtain a stratum through the levee impervious to sipe water. Or in case the chief constituent of the levee is stiff buckshot or clay, the chief engineer may require a wall of sand eight feet thick, to be continued up from the surface of the muck ditch to high water mark, as the levee is built up on each side of it, the object in this case being to obtain a perpendicular stratum through the levee impervious to crawfish. The extra cost of procuring suitable material for filling muck ditch and wall, if any, to be determined hereafter, in each case, and paid for.

5. When the ground is prepared as required by article 4, the embankment will be commenced, and a sufficient number of dumping men be kept on the levee to spread the earth as it is wheeled or carted in. The slopes shall in every case be commenced full out to the side stakes, and carried regularly up as the embankment progresses. The engineer in setting the center stakes will mark on them the height to true grade, but the contractor must build the embankment one-fifth higher than the height marked on the stakes (unless otherwise directed by the chief engineer), for shrinkage or settling; this allowance of one-fifth being so disposed on the top and slopes as to give the required width of 8 feet at the top of settling, and to fill out the slopes so as to make one plane from edge of crown to base of levee. Nothing will be paid for settling or shrinkage, but the levee will be paid for as estimated up to true grade. As each continuous quarter mile is thus finished, the contractor must notify the engineer in charge, and he will retrace the original center line of levee, and place on each side of it grade stakes, half the width of crown from the center line, driven to the elevation of true grade, plus one-fifth the height of the levee, at the respective stations. If the levee be found deficient in height, slopes, or base, or not to have the full settling on the top and slopes, the contractor must go over it immediately and correct all deficiencies, it being required to have the full amount of shrinkage over the entire quarter of a mile when the engineer sets the grade stakes. When the contractor has gone over it and corrected all deficiencies, the engineer will again run a test level over it, to see that it is all right.

6. Material taken from ditches or drains (except when otherwise directed by the engineer), shall be deposited in the adjacent levee, the cost of removing which, when the haul is not more than three hundred feet, will be included in the price paid for excavation. In procuring material for the levee, the place will be designated by the engineer (always on the river side unless otherwise directed) and in excavating and removing it, care must be taken to injure or disfigure the land as little as possible. In no case must it be obtained within 20 feet of the base of the levee on the river side; and the slope of the pit next to the embankment must not be less than one to one. If from unavoidable causes, it becomes necessary to procure material on the inside of the levee, it must not be taken within 30 feet of the base. But it is not to be taken from the inside at all, unless forced by high water, or some insuperable difficulty, and then only upon the written order of the engineer designating the place. Any encroachment upon the limits either side, must be measured by the engineer and deducted from the amount of the final estimate. At intervals of one hundred feet bermes must be left across the borrow pits to prevent the flow of a current along the levee. In procuring material for the embankment, if the place designated by the engineer exceed three hundred feet from the center line of the levee, one cent per cubic yard will be paid in addition to the contract price for every hundred feet of average haul exceeding three hundred feet that said material may be transported. All levees shall be estimated in embankment, and not in excavation, and be paid for by the cubic yard.

7. All earth designated for embankment must be entirely divested of roots, trash, and other perishable matter before being put in place.

8. In cutting drains, sipe ditches, or new channels for streams, they shall be cut at such distance from the levee as the chief engineer may require; the material deposited in the adjacent embankment, and paid for as specified in article 6 of these specifications.

9. The Chief Engineer may, whenever he deems it necessary, require a double course of sheet-piling, breaking joints, to be driven at the center or either side of the Levee five feet below the surface of ground, and extending up to within six inches of grade; the plank to be of heart red gum, white oak or cypress, or such other timber as the Chief Engineer may select, and of such dimensions as he may determine; the material and labor to be paid for by the thousand feet, board measure. All pilings must be driven in advance of the Levee, and the embankment constructed on both sides of the piling simultaneously. The chief engineer may, also, whenever he deems it necessary, require a breakwater to be constructed on the river slope of the levee, of post and plank wall, properly braced, and filled in behind with earth, according to detailed plan and specifications in the office—the material and labor to be paid for by the thousand feet, board measure, and the filling at the contract price per cubic yard, stipulated for embankment.

10. The line of levee or the gradients may be changed, if the chief engineer shall consider such change necessary or expedient, and for any considerable alterations, the injury or advantage to the contractor will be estimated, and such allowance or deduction made in the prices as the chief engineer may deem just and equitable; but no claim for an increase in price on the part of the contractor will be allowed or considered, unless made in writing, distinctly setting forth the grounds of such claim, and the amount of increase asked for, before the work on that part of the section where the alteration has been commenced. The chief engineer may, also, on the conditions last recited, increase or diminish the length of any levee.

11. Whenever the route of the levee is traversed by public or private roads, commodious passing places must be kept in safe condition for use; and in passing through farms, the contractor must also keep up such temporary fences as may be necessary for the preservation of the crops and protection of property.

12. No charge shall be made by the contractor for hindrance or delays, from any cause in the progress of any portion of the work in this contract, but it may entitle him to an extension of the time allowed for the completion of this work, sufficient to compensate for the detention to be determined by the chief engineer, provided he shall give the engineer immediate notice in writing of the cause of detention. Nor shall any claim be allowed for extra work, unless the same shall be done in pursuance of an order from the engineer and said claim therefor, properly certified, will be paid at the first settlement after the work is executed.

13. In anticipation of destructive floods during the progress of the work, the engineer may require a protection of timber work to be constructed around the ends of the levee, and also a temporary protection levee to be built in front of the work, upon such location as he may designate, and of such dimensions as he may direct. The chief engineer may also require the base of the levee to be covered with a causeway of timber, whenever necessary to support the embankment;

for which an extra compensation, to be determined in each case, will be made.

14. All damage or injury to the work, resulting from flood or other cause, shall be sustained by the contractor till finished and received by the chief engineer; and no work shall be received until fully and completely finished in accordance with the above specifications; and before any levee is finally received, all trees exceeding one foot in diameter within one hundred feet of the center line of the levee, must be felled. The word contractor, as used in this instrument, applies exclusively to the first party.

15. The above specifications, if not understood, will be fully explained by the engineer; but if willfully neglected, no measurement or estimate will be made on the work until they are complied with.

And the said Levee Commissioners agree to pay the first party, for completing this contract according to its terms, the prices affixed to the different items in the annexed schedule.

It is expressly understood that the prices herein stipulated to be paid, refer to final and accurate estimates of the work embraced in this contract; and it is further understood that the quantities and values of work embraced in this contract, at the date of its ratification as shown on the plans and profiles, are only approximate; and that no subsequent diminution or increase in the amount of work that may arise, either from error in the original estimates, or from any changes which the chief engineer may make in the gradients, alignment, or length of the levee, shall entitle the first party to any allowance whatever (except as provided for in Article ten of the Specifications) beyond a final estimate of the work, made from side-stake notes and other notes, taken on the ground before the work is commenced; it being particularly understood that no measurement of the work will be taken after its completion.

On or about the first day of every month, during the progress of this work, an estimate shall be made of the relative value of the work done, to be judged of by the chief engineer, and upon his estimate and certificate of the amount, approved by the President of the Board, being presented to the Treasurer, the amount of said estimate reserving fifteen per cent. of the same, shall be be paid to the first party, in the character of funds specified on the next page, under the "Schedule of Prices and Work," at the office of the Treasurer and Secretary of the Board, provided the amount due on said estimate to the first party shall be more than hundred dollars. And when all the work embraced in this contract is completed agreeably to the Specifications, and in accordance with the directions and to the satisfaction and acceptance of the chief engineer, there shall be a final estimate made of the quality, character and value of said work, pursuant to the terms of this agreement, when the balance appearing due to the first party shall be paid to upon giving a release under seal, to the Levee Commissioners from all claims or demands whatsoever, growing in any manner out of this agreement.

It is further covenanted and agreed between the parties, that the first party shall not let or transfer this contract, or any part thereof, to any other person (except for the delivery of materials) without the consent of the chief engineer; but will give personal attention and superintendence to the work. Nor shall the first party employ any person who commits depredations on the neighborhood, or insults travelers or other persons; and all such disorderly persons shall be discharged from employment whenever the first party shall be directed so to do by the engineer.

It is further agreed and understood that the work embraced in this contract shall be commenced in days from this date, and prosecuted with such force as the chief engineer shall deem adequate to its completion within the time specified; and if at any time the first party shall refuse or neglect to prosecute the work with a force sufficient, in the opinion of the said engineer, for its completion within the time specified in this agreement, then and in that case the President of the said Board of Mississippi Levee Commissioners may employ such number of workmen, laborers and overseers as may, in the opinion of the chief engineer, be necessary to insure the completion of the work within the time hereinbefore limited, at such wages as he may find it necessary or expedient to give; pay all persons so employed, and charge the amount so paid to the first party, as for so much money paid to said first party on this contract; or the chief engineer may at his discretion, for the failure to prosecute the work with an adequate force, for non-compliance with his directions in regard to the manner of constructing it, or for any other omission or neglect of the requirements of this agreement and specifications on the part of the first party, declare this contract, or any portion or section embraced in it, forfeited; which declaration and forfeiture shall exonerate the second party from any and all liabilities and obligations arising under this contract, the same as if this agreement had never been made, and any amount reserved upon any work done by the first party, may be retained forever by the second party. And it is mutually agreed and distinctly understood that the decision of the chief engineer shall be final and conclusive in any dispute which may arise between the parties to this agreement, relative to or touching the same; and each party hereby waves all right of action, suit or other remedy in law or otherwise, by virtue of the said covenants, so that the decision of the chief engineer shall, in the nature of an award, be final and conclusive on the rights and claims of said parties.

TECHNICAL EDUCATION.

THE MISSING LINK SUPPLIED.

At a meeting of the Board of Trustees of the Polytechnic College of the State of Pennsylvania, held in Philadelphia, Febuary 26th, 1877, the following resolution was adopted:

Resolved—In view of the necessity for the better preparatory training of technical students, that the President of the Faculty be and he is hereby authorized to prepare a course of studies for a 'Preliminary Year' or preparatory department, and to organize said department, the qualifications for admission to which shall be those now required of teachers in the Common Schools of this Commonwealth.

The importance of the above action will be better understood when it is remembered, that in this country technical education has never been organized into a progressive system. The pupil of our grammar, graded, high or normal shools who wished to pursue a technical course, found himself almost entirely unprepared, except in the single study of mathematics. Did he wish to pursue a classical course, he found academies everywhere, especially designed to train him for admission to the literary college; academies in which the whole time of the Principal is employed in drilling the Latin and Greek classes, and that work is doubtless well done. But the youth who wishes to prepare himself for the honorable and lucrative calling of the Civil or Mechanical Engineer, Architect, Furnace Builder and Manager, Mine Engineer or Chemist, has no such opportunity. When he leaves the Grammar School there is no place provided where he can especially pursue a course preparatory to entering upon his professional studies. He has to get a little instruction here, and a little there, and the baneful effects of imperfect preparation follow him throughout his future career. In fact, it may be said that neither institutions devoted to Technical Education nor their students have had a fair chance in America, because the link between those institutions and the Grammar School has always been missing.

In Europe it is not so. There the technical student is provided with a regularly progressive course, arranged to fit him thoroughly for the applied studies which are to follow. Now this is just what he needs here, and what the above action of the corporators of the Polytechnic College is going to supply in the course of their "Preliminary Year." The time seems short, but as none but *industrious* youth are supposed to aspire to the industrial professions, it is doubtless long enough for the introduction of Drawing, and the elements of Experimental Science and Natural History, in which intelligent foreigners who visited us last year found our schools so lamentably deficient as compared with theirs. Despite these obstacles, Technical Education has during the last quarter of a century made rapid strides, and the Polytechnic College has reason to be proud of the success which has attended her graduates. With the facilities for admission afforded by the organization of the Preliminary Year, she will doubtless have a large accession to her classes.—*Exchange.*

THE following are the elections, changes, and corrections for the month of July, 1877, in the membership of the American Society of Civil Engineers.

Additions:—John W. Bacon, Danbury, Conn; Frederic S. Benson, Engineer Nassau Gas Light Co., Brooklyn, N. Y.; Charles E. L. B. Davis, Lieut. of Engineers, U. S. A., Galveston, Texas; Arthur [J.] Macy, 159 Henry st., New York; Benjamin F. Morse, City Civil Engineer, Cleveland, Ohio.

Changes and Corrections:—George S. Baxter, (care Am. Soc. Civil Engs.), 104 East Twentieth st., New York; John C. Bland, 530 Walnut st., Philadelphia, Pa.; Thomas B. Brooks, Box 298, Newburgh, N. Y.; Theodore Cooper (Care Delaware Bridge Co.), 52 Wall st., New York; Edmund L. DuBarry, Supt. C. D. & V. R. R., Chicago, Ill.; Augustus Jay DuBois, Prof. Dynamical Engineering, Sheffield Scientific School, Yale College, New Haven, Conn.; Wheeler C. Durham, 166 Pine st., Chicago, Ill.; Albert Fink, 346 Broadway, New York; Edward A. Flint (Care B. Kimball), 14 Sears Building, Boston, Mass.. William A. Gunn, Lexington, Ky.; Charles Hilton, 105 Lancaster st., Albany, N. Y.; Max Hjortzberg, 387 North LaSalle st., Chicago, Ill.; Sandford Horton, Div. Eng. C., C. & B. H. R. R., Covington, Dakota Co. Neb.; Gabriel Jordan, Vice-Pres. and Gen. Mang. H. & T. Cen. R. R., Houston, Texas; John C. Kennedy, Florence, N. J.; Othniel F. Nichols, 141st st., near Willis ave. (Morrisiania), New York; William D. Pickett, Helena, Mon.; Edward C. Rice, 3631 Baker Av., St. Louis, Mo.; Alfred L. Sears, Chimbotu, Peru; Isaac W. Smith, (Care Williams & Thornton) San Francisco, Cal.; Henry W. De Stuckle, (Care William E Worthen) 63 Bleeker st., New York; Charles A. Tasker, Res. Eng., C. S. R. R., North Tower, Jessamine Co. Ky.; Francis L. Vinton, Denver, Col.

Deceased:—Robert L. Cooke, New York; Charles E. Emack, Culpepper, Va.; William B. [F.] Ogden, New York.

CORRESPONDENCE.

PHILADELPHIA, *August 27, 1877.*

EDITOR ENGINEERING NEWS.

SIR.—I beg leave to call your attention to several errors in Latham's Sanitary Engineering; and as you have done such great service towards bringing that excellent work under the notice of American Engineers, you will no doubt be glad to correct them, especially as they have been copied into your reprint.

On page 15 of your addition are the formulæ of Weisbach by which the tables on the previous pages were calculated and it is there where the errors occur.

$$v = \frac{64.38}{1.505 + \frac{c\,v\,i}{d}}$$

1. The formula is wrong and should be

$$v = \frac{\sqrt{64.38 \times v}}{\sqrt{1.505 + \frac{c\,v\,i}{d}}}$$

v is left out in the numerator, as is also the radical sign over the whole expression.

It might be well to state, as the formula might puzzle a great many at first, that the two v's on the right side of the formula and the c (depending on the value of v) are to be inserted approximately to find a more accurate value for v on the left side; this in turn is substituted in a second calculation and so on until v on the left is found to be the same as the value substituted for v on the right.

2. The table of the Coefficients for friction in the pipe is an exact copy from Weisbach's work in German, and it there refers to *Prussian feet.* (1 Prussian foot = 12.36 English inches.) It should therefore be remembered that all those tables in Latham's Engineering refer to Prussian feet, which is not mentioned anywhere I believe.

Mr. Coxe, in translating Weisbach's Mechanics has reduced this table to English feet, see page 869, which differs accordingly from the one published in Latham's Work.

3. It has been omitted to call attention to a remark that Weisbach makes in reference to the coefficient e for entrance of water into the pipes. Mr. Latham says: e is at an average = .505 (the decimal point is not printed in your edition), but may be reduced to .03 by rounding off the inlet. Mr. Weisbach adds "that it may even be reduced to 0 in long pipes." Therefore it should be borne in mind, as the coefficient .505 has been substituted in the above mentioned formula, by which the tables are calculated, that these tables apply only to short pipes (and to such where the inlet has *not* been rounded off), therefore not to sewers in general with much accuracy.

Weisbach's formula does not take into account the coefficient of friction depending on the roughness of the wetted perimeter. It may be true that it is not perceptible in small pipes, but in larger water ways its value is all important, as more recent experiments of Bazin & Kutter have shown Weisbach himself applies his formula only to pipes of 12″ diameter and below; but Latham applies it also to much larger diameters, even up to 10 ft. which is evidently over strained and was not Weisbach's intention, nor does it give results in accordance with experience.

In the appendix, on page 69 of your publication, mention has been made of the new formulæ of Bazin (not Barzin as printed) and Kutter, which, being deduced from actual experiments with large channels, must therefore, necessarily give more reliable results than Weisbach's formula does in cases over 12″ diameter.

As it is only quite recently that Kutter's valuable contributions towards establishing a reliable theory of the flow of water have been made known to English Engineers, it might be well to call the attention of your readers to them, especially as represented in the works of Lewis D' A. Jackson, and at the same time to caution any one using Weisbach's formulæ or the tables calculated therefrom, as to the extent to which they can be used with safety. Yours respectively,

RUDOLPH HERING.
Assistant Engineer, Survey Department.
224 S. Fifth street.

ERRATA.—In article No. 2, on "Our Railways and their Economical Use" published in our last issue, in the 15th line from the top of page 223, "*for a railroad*" should read "*for an extensive railroad.*"

THE SCIENCE OF ROAD MAKING.*

BY CLEMENS HERSCHEL, OF BOSTON,

Civil Engineer, Member of the American Society of Civil Engineers.

(*Continued from page 230.*)

"The statistics of the road repairs are kept in the following manner. The road-keepers are required to keep a record of all draught animals that pass in either direction. Horses that are being ridden, animals not before a vehicle, and teams going to and from the fields, are not counted. These records are kept only during the working hours. Likewise, not during the whole year, but only four months in each year, so selected as to give an average amount of travel. The travel on the road on Sundays and out of working hours is taken from a few observations; it is a very small percentage of the whole. At the end of the year these records and observations are collected and graphically represented on a map of the whole State. The different roads are drawn of a different thickness of line, according as the amount of travel on them is greater or less. The quantity of road metal used per yard of road, and the kind of metal used, give the data for another such map, in which the different colors of the roads represent the different materials used in their repair, and the figures on them and their thickness show the number of cubic yards per mile required to keep the road in order. Finally, we have a third map, which indicates, by the thickness of the several lines representing the roads and by the figures on them, the total cost per mile of repairing the road one year."

With this picture of a country happy and prosperous, in the possession of good and well-kept roads, it may be well to leave the subject.

Massachusetts wants for her proper development, much better roads than she now has; and, reckoning for a period of say fifty years, she can have these good roads, and have them kept in order, at a less cost than that of keeping up the present poor ones for the same time. Besides this, we should see in the one case a healthy state of internal communications and trade; in the other an absence of both. Let each citizen so act and do his part, that these benefits may accrue to the Commonwealth.

For the sake of arriving at some practical end I have requested the gentlemen to whom the prizes for essays were awarded to suggest what form of legislation would be desirable as a change from our present inefficient system of road management, to one which should promise better, more economical and more satisfactory results. The large and varied experience and observation of these gentlemen, all of whom are competent engineers, entitle their opinions and judgment to favorable consideration; and the following, submitted by them, may serve as a basis or outline for future legislation:

AN ACT FOR THE MORE PERFECT CONSTRUCTION AND MAINTENANCE OF THE COMMON ROADS OR HIGHWAYS THROUGHOUT THIS COMMONWEALTH (MASSACHUSETTS).

SEC. 1. Establishes a body to be known as the State Board of Highways and Bridges, to consist of three skillful civil engineers, or persons practically expert in the science of road-making, to be appointed by the Governor with the advice and consent of the Council, and to have their office in the State House.

SEC. 2. It shall be the duty of the Attorney-General, personally or by his deputy, to give his council and opinion on such matters as he may be called upon by the Board, for which service his compensation shall be

SEC. 3. The first appointment of members of the Board of Highways and Bridges shall be made on or before , and there shall be appointed one member each for the terms of one, two, and three years; after that there shall on or before each year be appointed one member for the term of three years.

SEC. 4. Each member of the Board shall receive an annual salary of dollars; give bonds for the faithful discharge of his duties; pay over all moneys, papers, etc., at the expiration of his term or when ordered by the Governor and Council.

SEC. 5. Board are to elect a president and treasurer, and make their own by-laws.

SEC. 6. A majority of the Board constitutes a quorum; records to be kept of all the proceedings; copies of all plans, estimates, etc., to be kept; report to be rendered on or before each year, or when required by the Governor and Council. Each member authorized to administer legal oaths.

SEC. 7. Said Board shall prepare and submit to the legislature a plan for the systematic classification of all the highways and townways in this Commonwealth into two or more of the following three classes:—

Class 1. State roads, to be controlled and maintained wholly by the State.

Class 2. District roads, to be controlled and maintained by the State, but the expense thereof to be borne by the towns and cities of the districts in which said road shall lie, and the State, in such proportions as said Board shall apportion.

Class 3. Town roads to be controlled and maintained as now provided by law.

The construction of new roads, of the three classes above specified, to be done as follows:—

Class 1. State roads, to be laid out and built by the State, through the Board of Highways and Bridges.

Class 2. District roads, to be laid out, etc., by the county commissioners, as now provided, but the board to have the final approval or disapproval of the proposed plans and profiles for said road, and also to have the charge and superintendence of their construction.

Parties aggrieved by the refusal or neglect of county commissioners to lay out a road, to have the right to appeal to the Board of Highways.

Class 3. Town roads, to be laid out and constructed as now provided by law.

SEC. 8. The paying of road taxes by labor is hereby abolished, and all road taxes are hereafter to be paid in cash.

SEC. 9. Board shall have the special charge and superintendence, subject to the laws and resolves of this Commonwealth, of all the highways and bridges, and the public works appertaining thereto, which are or shall be executed or maintained, wholly or in part by this Commonwealth. They shall also perform such other duties as may be required of them by the general court or the Governor and Council.

SEC. 10. Whenever any highway or bridge, or public work appertaining to these two, shall come partly within the province of this Board, and partly within that of any other State board, already constituted, then such subject shall be discussed and decided upon in a joint convention or conventions, composed of equal numbers of this and the said other State board, and some member by them chosen as presiding officer.

SEC. 11. All applications or propositions for improvements or new works, of the kind specified in section nine as coming within the province of this Board of Highways and Bridges, and intended to be laid before the legislature, shall hereafter be first made to this Board. Upon receiving such application, Board shall investigate same, and if they find such work necessary and proper, shall thus report to the legislature, with an estimate of the expense thereof; if they do not approve of such application, they shall report the reasons for their disapproval.

The Board may also, in like manner, recommend, whenever they think proper, any improvements of the kind above specified, though no application has been made therefor.

SEC. 12. It shall be the duty of the Board to procure for the legislature full plans and estimates of contemplated works or improvements when so ordered by the legislature.

SEC. 13. Whenever any work shall have been authorized or ordered by the general court and the money appropriated therefor, Board shall advertise for proposals for doing said work; plans and specifications of the same first to be placed on file in office of Board, which plans and specifications shall be open to public inspection; advertisement to state work to be done and to be published ten (10) days at least. The bids shall be sealed bids, directed to Board and accompanied by bond to the Commonwealth signed by bidder and two responsible sureties, in sum of two hundred ($200) dollars, conditioned he shall do the work if awarded to him, in case of his default to do so, forfeits, &c. Bids to be opened at time and place mentioned in advertisement.

SEC. 14. All contracts shall be awarded to the lowest responsible bidder and who sufficiently guarantees to do work under superintendence and to satisfaction of Board; provided that the contract price does not exceed the estimate or such other sum as shall be satisfactory to Board. Copies of contracts to be filed with state auditor.

SEC. 15. Board reserves right in contracts to decide questions as to proper performance of work and meaning of contracts; in case of improper construction may suspend work and relet the same; or order entire re-construction; or may relet to other contractors and settle for work done, &c. In cases where contractor properly does work, Board may in their discretion as work progresses, grant to said contractors estimates of amount already earned, reserving fifteen per cent. therefrom, which shall entitle holder to receive amount, all other conditions being satisfied.

SEC. 16. In case prosecution of any public work be suspended, or bid be deemed excessive, or bidders be not responsible, Board may, with written approval of governor, where the urgency of the case, or interests of the Commonwealth require it, employ workmen to perform or complete any work ordered by the legislature: provided, that the cost and expense shall in no case exceed the amount appropriated for the same.

SEC. 17. All supplies of materials, &c., when costing over five hundred ($500) dollars, to be purchased by contract, subject to same conditions as letting out work.

SEC. 18. Whenever Board think necessary, for interests of the Commonwealth, to protect same from damage or loss, shall report

*A First Prize Treatise awarded to the Author by the State Board of Agriculture, of Massachusetts.

thus to governor and council and reasons for same, asking power to give contracts without notice required above, and governor and council may grant request, provided three-fourths vote for it.

SEC. 19. Whenever Board is of opinion a work may be done better without a contract, shall so report to legislature, and they shall procure machinery, materials, &c., hire workmen, &c., to do said work, whenever so authorized by the legislature.

SEC. 20. All contracts and bonds by Board to be in the name of the Commonwealth.

SEC. 21. No member of the Board to be interested in any contract; all contracts made with any member interested, governor may declare void, and shall remove such member so interested from office. It is the duty of every member of the Board and every officer of the Commonwealth to report any such delinquency, if discovered.

SEC. 22. Board shall be empowered to employ such engineers, clerks or other assistants, as shall be provided for by the legislature.

SEC. 23. Board shall, on or before every year, submit to the auditor, by him to be presented to the legislature with his annual estimate, a statement of the repairs and new work needed for the current year, and of the sums required by the Board therefor; report to be in detail; all sums appropriated therefor to be included in the annual tax-levy.

SEC. 24. All moneys to be paid to any person out of moneys so raised, shall be certified by president of Board to auditor, who shall draw warrant on treasurer therefor, stating to whom payable and to what fund chargeable; such warrant to be countersigned by president of Board.

SEC. 25. Board to keep accounts, showing moneys received and spent, clearly and distinctly, and for what purpose. Accounts to be always open for inspection of auditor or any committee appointed by the legislature.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR.*

The work now in progress for the improvement of the entrance to the harbor of Galveston, Texas, consists in the application of the jetty system, in one of its well-known forms, to a drift bar.

The jetties are of the type known as "right line," "drowned jetties," and are designed simply to arrest, in a measure, the sand drifted along the gulf coast by the action of the winds and waves, and to train the currents caused by the daily tidal discharge of Galveston bay. The most interesting feature of the work is esteemed to be the novel method adopted for the construction of the jetties or "gabionades," as they have been styled.

I will confine this paper mainly to a description of this method, first, however, giving a general idea of the conditions calling for improvement of the harbor and those which have governed in the selection of a plan for improvement.

Galveston is the principal seaport of the rapidly growing State of Texas. It occupies a central position on the coast, the more populous portions of the State considered, and with this portion is connected both by rail and water. Nature has given it the best outlet channel to be found on our coast, west of the Mississippi river, a channel ranging from 11 to 12 feet in depth at mean low tide. This depth, of late years, has been found insufficient to meet the necessities of commerce. In consequence, the present work was undertaken by the general government, with the reasonable expectation of increasing the channel depth, to at least 20 feet.

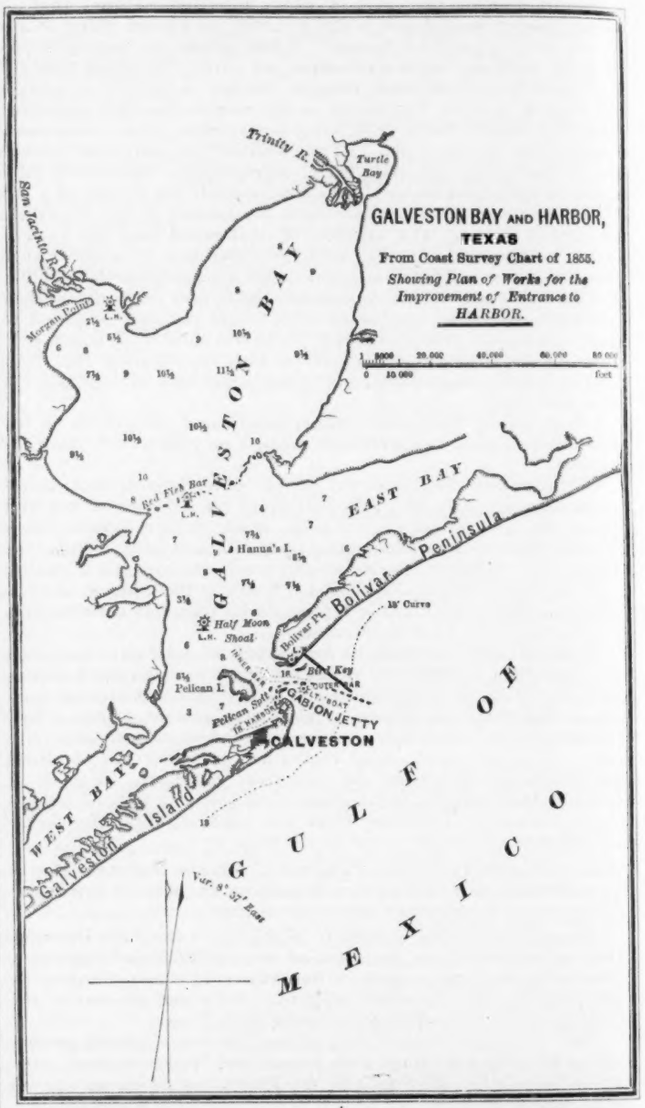
The city of Galveston is located on the east end of a long, narrow, sand island, running parallel to the main land and separated from it by a shallow bay called "West bay." North of the east end of the island is the broad expanse of "Galveston bay," and to the northeast is "East bay," running well up toward Sabine pass and behind Bolivar peninsula. These bays, having a combined area of about 455 square miles, are connected with the gulf by the Bolivar road-stead, separating Galveston island from the Bolivar peninsula. Through this the tides daily flow and ebb, creating tidal currents which have made and which maintain a broad, deep channel between the headlands.

This channel is separated from the deep waters of the gulf by a sand-bar of nearly semi-circular shape, formed in accordance with the well-known laws governing the formation of purely drift and tidal bars. This is called the "outer bar," and the normal depth of channel across it has been, for such time as we have record, about 12 feet.

Galveston harbor is a branch of the Bolivar road-stead, leading along the inner face of Galveston island toward West bay, and at the time of commencement of the work which is the subject of this paper, was separated from the road-stead by a bar, across which there was a channel but 11 feet in depth. This is called the "inner bar."

The channel across this, is reported to have been 30 feet in depth in the early part of this century, and within the time covered by authentic record is known to have steadily shoaled up to the time of commencing the work of improvement. This shoaling, as it now appears, was rightly attributed to the continued abrasion of the east end of Galveston island, and there was reason to fear that if further abrasion was not prevented, the harbor would, at no very distant day, be rendered useless. To simply prevent further abrasion would not insure greater depth of channel, it was, therefore, decided, as the first step, to build the end of the island out to the place it was said to have held when the channel was 30 feet in depth.

FIG. 1.



This work was commenced by the city of Galveston before the assistance of the general government was obtained, and a pile pier extended several hundred feet beyond the end of the island, but not far enough to obtain valuable results. From the outer end of this pier, which was partially destroyed by the great cyclone of Sept. 1875, and has since been repaired, a gabionade was carried out 1,200 feet, which had the effect of deepening the inner bar channel to 16½ feet, mean low tide, and of shortening the bar, between 18 foot curves, to 450 feet, a shortening of 5,240 feet. This condition has been maintained without material change for a year and a half.

Further extension is now in progress, and further improvement of channel is anticipated. On the gulf side of the gabionade, the changes effected by it are no less marked than those effected in the inner bar channel. The shoals lying immediately between this and the gulf to the south and east have been largely built up and extended, and have served to divert the ebb-tide currents more directly along the axis of the road-stead. In this way, a direct broad and somewhat deeper channel has been produced across the outer bar, and that on the line designated in the general plan for the channel after completion of the works proposed.

The work designed for improvement of the outer bar is to consist of a pile pier extending directly out from a point near the end of Bolivar peninsula to the curve of 6-foot depth, after which it is to be prolonged as much farther as may be found necessary, by a gabionade.

The gabionade is simply designed to form the nucleus for a sand

* By CHARLES W. HOWELL, Corps of Engineers, U. S. A., A. S. C. E. Transactions of the American Society of Civil Engineers.

shoal, which latter is to perform the office of guiding the ebb currents and of protecting the results of their scour from being entirely neutralized by shore drift. Entire protection is not to be sought, for it is not now believed that it will be necessary.

The work planned for the outer bar, is to run out from the Bolivar peninsula, instead of making an extension of the island gabionade toward the gulf, for the reason that the prevailing winds are from an easterly direction, and the consequent race of the waves along the coast, from which protection is most desirable, is from that direction.

The extension of the island gabionade, by turning it so as to bring its outer bar portion parallel to that from the peninsula, has been considered as a possible necessity, but will not be undertaken until the latter is completed and shown to not give a desirable measure of improvement. If fully completed as laid down on the chart, (Fig. 1,) the peninsula gabionade will be about 4½ miles in length, and laid down in water ranging from 4 to 12 feet in depth. There is some reason to think, however, that it may not be necessary to project it out more than 2½ or 3 miles, and a large portion of this it is expected will be so far advanced this year as to give marked results,—perhaps as good as those obtained on the inner bar.

It is also thought, that it will not be necessary to build the gabionade up as near the surface of the water as the plane of mean low tide. These, however, are but impressions, which the work will be so conducted as to test.

Tidal currents being the active agents upon which the work depends for success, it is proper to state that their velocity is too variable to more than say of it, that it has seldom been observed to be less than that required to move the fine, rounded sand, of which the bars are mainly composed, to a depth of 24 feet. From hourly observation made previous to commencement of the work, and for ten consecutive months, it was ascertained that the extreme range of the tides for that period, during which no extraordinary storms occurred, was 5½ feet.

The plane of mean low tide established from this, and since retained as our plane of reference, proved to be that of the lowest high tides for that time. The tides ranged above this, 3¼ feet, and below it, 2¼ feet. The greatest daily range was 3.2 feet, and the least 0.4 feet.

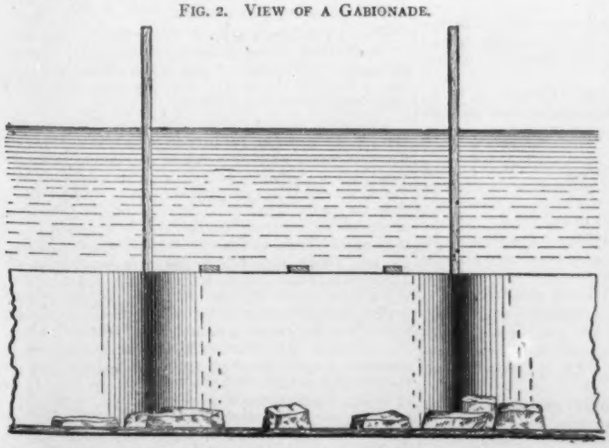
The ebb tides are considerably re-inforced by the drainage of the basin tributary to the bays; this, however, is only notable during the rainy season. The drainage is ponded back in the upper portion of the bay by the flood tides, and there deposits its sedimentary matter, after which it passes to the gulf with the ebb, clear, except when the bottom of the bay is stirred by storms.

The outline chart, Fig. 1, shows the general features of the bay, harbor and entrance, and the location of the gabionades.

A gabionade consists of a number of gabions, filled with sand and sunk in line upon fascine or hurdle mats, with which the bar surface along the line is carpeted to prevent settlement of the structure. The gabions used on this work are large boxes with semi-cylindrical ends and straight sides of basket-work, and with flat tops and bottoms of heavy planking. For the basket-work, we have used small pine poles as stakes and sea cane for wattling. The stakes are from 1½ to 1¾ inches in diameter, and are fastened to tops and bottoms through auger holes in these. The sea cane averages about ½ inch in diameter at butt. The cane is thought to be not subject to attack of the teredo—it is also enduring under water, and very pliable for several weeks after cutting. It is abundant and cheap, as is also the case with the pine stakes.

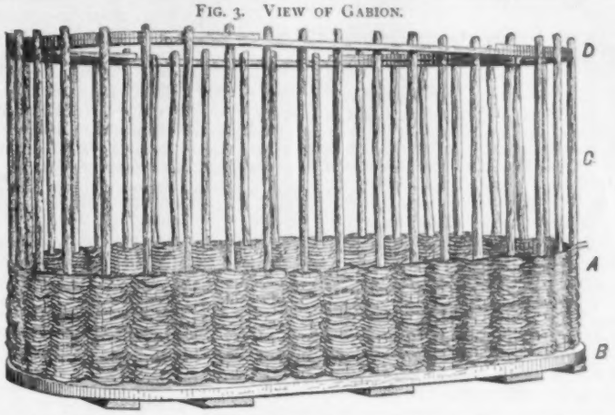
Fig. 3 shows wattling of sides and ends; *A*, being wattling—*B*, bottom—*C*, stakes, and *D*, temporary frame.

FIG. 2. VIEW OF A GABIONADE.



The basket-work, both inside and outside, is heavily coated with a rich hydraulic cement mortar, making the walls from 5 to 6 inches in thickness, and this is allowed to weather-season for three months before being transferred from the construction yard to the gabionade. The tops are carbolized and covered with mortar (the same as the walls), which is secured in place by bevelled cross-pieces on the top.

FIG. 3. VIEW OF GABION.



A stiffening frame is provided inside the gabion, at 2 feet from the bottom, and another at 2 feet from the top. Two holes are left in the top for the introduction of sand, and are closed after filling.

The longer axis of each gabion is 12 feet, the shorter 6 feet, and the height is 6 feet. The weight filled is about 19,000 pounds; smaller sizes have been used at special points, for spurs.

Of the mats for preventing settlement of gabions and for modifying scour in advance of construction, two kinds are in use.

The "fascine" mat is made up of fascines, each 12 feet long and 6 inches diameter, fastened together with wire to form mats 12 × 6 and 12 × 9 feet. One of the former and two of the latter are used for each gabion. The fascines are made up from the cane trimmings and from cane unfit for wattling. The "hurdle mat" is made with pine poles and a wattling of untrimmed cane, making a bushy mat about 4 inches in thickness, 12 feet in width and 24 feet in length. Both kinds of mats are strong and flexible enough to conform to the shape of the bottom.

FIG. 4. PLAN OF GABION AND FASCINE MAT.

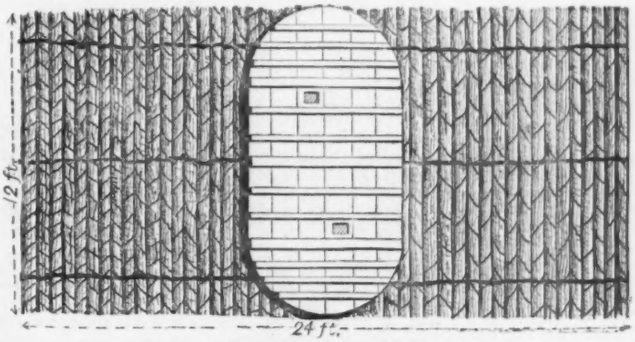
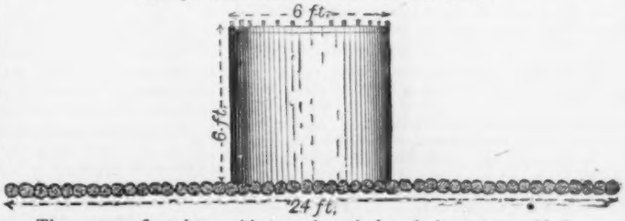


FIG. 5. ELEVATION OF GABION AND MAT.



The mats are floated to positions and sunk by placing concrete blocks upon them. These blocks are made of broken brick, gravel and beach sand, with only sufficient cement to bind the mass together and permit handling without breaking.

To guide in placing mats and gabions in position, the line of the gabionade is marked out some distance in advance, by pine piles, 12 feet apart. Between these the mats are sunk.

To sink a gabion, it is floated in between two piles, pumped full of water and lowered to its place. With a sand pump (Andrew's patent), it is then filled with sand. After completely filled, the holes in the top are closed and the gabion becomes, to all intents and purposes, a solid block of stone. Where intervals may be left between gabions, these are closed by large fascines wedged in and fastened with wire and blocks.

A description of the plant employed on the work would make this paper too long, and besides, possess no points of special interest.

In conclusion, I will remark that the work, when inaugurated, had many features considered experimental in character. Many of these have stood the test of severe trial, with credit. It was not known, if the gabions would stand against the shock of the waves during severe storms. The cyclone of September, 1875, gave strong evidence of their stability Those in the gabionade retained their places, and even those which were in the construction yard on the end of the Island, and which were also well seasoned, although the waves broke several feet over them, at the close of the storm were found to have moved but little, to have remained upright, to have sustained but unimportant damage and to have been filled with sand by the waves breaking over them. They have been found to serve admirably as the nucleus for a sand shoal, and in but few cases has the sand failed to completely cover them so that they could only be found by probing.

The cost per running foot of gabionade, 6 feet high and 6 feet wide, was found before the storm to be $5.21. Since, many additions have been made to the original design, which will probably bring the cost up to about $8.00. No exact estimate, however, will be attempted until the close of this year.

The work is claimed to have shown efficiency, durability and cheapness combined. Should further and just expectation be realized, a valuable precedent will be established for the improvement of other drift bars upon the gulf and lower Atlantic coast, where works will not be called upon to resist the action of ice.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

Robert Moore, C. E., of St. Louis, has just been confirmed as Sewer Commissioner of that city. This officer has charge of the entire sewerage of the city, and is one of the members of the Board of Public Improvements.

BRIDGES.

The Commissioners of Warren county, Ohio, propose to erect a new bridge over Twin Creek, near Franklin, in that county.

A wrought iron tubular bridge will soon be erected over the Brazos river, at Courtney, Texas. The bridge will be 400 feet in height.

The contract for building a swing bridge at North avenue in this city, was let last Monday to Conro, Carkin & Co., of Chicago, at $7.149.

The Massillon Iron Bridge company of Massillon, Ohio, has contracted for putting up a new iron bridge of sixty-three feet span at Bozrahville, Conn., and also one of fifty feet span at Lebanon.

The covered bridge spanning the Tuscarawas river, just south of New Philadelphia, O., was completely destroyed by fire, on the 25th ult. It was a three span, double-track bridge 325 feet long. Loss about $40,000.

Workmen are engaged in tearing down the old market in Brooklyn, N. Y., to make room for the bridge approach. The property taken for the bridge approach on the Brooklyn side has thus far cost a trifle over $112,000.

Work on the Short bridge at Danville, Ill., has been resumed. A. C. Garland, of that city, has charge of the stone work, and will raise the middle pier three feet and the eastern abutment six feet, after which the new bridge will be speedily erected.

The Quincy (Ill.) *Daily Whig* of the 22d ult., says:—"The Western Illinois Bridge company, having again secured the right of way from the Council will take measures to commence the building of a railroad and wagon bridge across the Mississippi as soon as possible."

It is reported that some "vandal" has blown up with powder the Elliot county, Ky., Natural Bridge. The bridge spanned a small tributary of the Little Sandy river, 150 feet wide, and stood 90 feet above the stream. Above and under the bridge a rainbow was visible daily when the sun was shining.

The work of clearing away the *debris* of the fallen span of the Chicago & Northwestern R. R. bridge over the Des Moines river, at Moingona, Ia., framing and putting in place a new span 170 feet long, and laying the ties and rails ready for the trains, was accomplished week before last in the short time of seventeen hours after the arrival of the material, which was shipped from Clinton, Ia, and reached the spot, some 206 miles, within twenty hours after the accident happened.

The Rensselaer and Saratoga railroad bridge crossing the most northerly branch of the Mohawk river at Waterford, N. Y., was destroyed by fire about one o'clock Sunday morning, the 19th ult. At the Waterford end of the bridge was a draw which was saved by the firemen, and the trestle work on Peeble's island at the opposite end was saved by the inhabitants of the island. The two spans forming the central portion of the bridge were totally consumed. The fire was undoubtedly the work of incendiaries. It is said that a substantial iron structure will take its place.

Several meetings have recently been held in Ottawa, Ill., in the interest of a free bridge over the Illinois river at that place. The project of building a new bridge in place of purchasing the present one is considered favorably, as it is estimated that the latter cannot be considered safe for over a year longer. A report was made at a meeting held on the 17th ult., to the effect that the piers and approaches of the present bridge could be utilized in a new bridge and that a new iron superstructure could be built for about $18,750. The Commissioners of the town of South Ottawa have decided to call a town meeting to vote upon the question.

During a severe storm on the morning of the 25th ult., two spans of the east end of the Union Pacific R. R. bridge at Omaha, were lifted from the columns supporting them and precipitated, one upon the embankment at the Iowa approach to the bridge, and the other into the Missouri river. The accident was doubtless caused by the violence of the wind, amounting almost to a tornado, which prevailed, a theory that the bridge was struck by lightning not being considered by good authorities, as being well grounded, as the twenty-two columns of iron having their base in the water, and resting on bed rock, are the best conductors of electricity in the world. The bridge is said to have cost over $2,000,000. and is 2,750 feet long, divided into eleven spans of 250 feet each. The portions of the structure destroyed will be rebuilt at once.

RAILROADS.

Steam street cars commenced running successfully on the 21st ult. in Brooklyn, N. Y.

About sixty convicts are working upon the International R. R. track near Houston, Texas.

The Cream City Street R. R. company of Milwaukee will soon receive a Baldwin steam car.

The work of obtaining subscriptions to aid the construction of the Ann Arbor, Mich., & Toledo, Ohio, R. R. is progressing finely.

Rumor says that the Jackson, Lansing & Saginaw, Michigan, R. R. will be completed through to Mullett's Lake this fall or next spring.

The Port Dover & Woodstock, Ont., R. R. is asking for more help from the municipalities along the line. The prospect is bright of its being granted.

Oshkosh, Wis., business men have organized a company to build a railroad connection northwest, to intersect the Central and Green Bay & Minnesota railroads.

The directors of the Pittsburgh, Wheeling & Kentucky R. R. have let the contract for grading, masonry, etc., and it is believed the road will be in running order by December 1st.

The surveyors of the Miami Valley R. R. reached Jamestown, Ohio, on the 18th ult. The object is to extend the road to Columbus, thus having a direct line from Cincinnati to Columbus.

The Cincinnati *Enquirer* says: "The building of the Cincinnati, Milford and Fayetteville narrow-gauge R. R. is a fixed fact. The full amount of subscriptions has been made, a Board of Directors elected, and the work will be commenced at once."

At the end of the first quarter of the present year the receipts of the six great French railway companies showed an increase of three millions of francs, compared with the same period of 1876; at the end of June the whole of that increase had been lost, and three millions more.

I. V. Baker, president of the New York & Canada R. R., who recently purchased the road-bed and franchises of the proposed new road from Mechanicsville to Fort Edward, N. Y., via Schuylerville, says that there is no present prospect of building that road. The franchise will be held subject to a favorable change in the finances and business of the country.

GAS AND WATER-WORKS.

Carthage, Mo., is to be lighted with gas.

Gas was first used as an illuminating agent in 1702. Its first use in New York, was in 1827.

Buffalo, N. Y., has resolved to build a new reservoir, at a cost vaguely estimated at from $300,000 to $1,000,000.

The Yonkers (N. Y.) *Statesman* complains because cows are permitted to wade in the water works reservoir.

As soon as practicable the Gloversville, N. Y., waterworks contractors will add 100 men to the present working force of 200.

It is anticipated that the St. John's, N. B., gas company will be in a position to again supply gas to the city by the 1st of October next.

The Board of Public Works, of Cincinnati, are causing drawings to be made of all the water-pipes in the city, and the valves, showing size and location.

Inflammable gas is found near Richfield Springs, N. Y., and it is suggested that the village be lighted with it, as the supply is thought to be abundant.

To meet the rates charged by its new competitor, the Harrisburg, Pa., gas company is now furnishing gas to consumers at the low rate of 90 cents per thousand.

The price of gas in London, Eng., is limited by the law to $1.10 per thousand feet of twelve candle power, and constant and close supervision keeps the quality up to the standard.

The Mutual Gas Light company, of Brooklyn, N. Y., capital stock $3,000,000 (a new company), has contracted to supply private consumers at $2, and the city at $1.75 per 1,000 cubic feet.

The little town of Santa Clara, California, is excited over the water problem. The question as to whether the water company is entitled to charge for water furnished for municipal purposes is to be tested.

The work of digging the ditches to receive the pipe for the new water works in Urbana, Ohio, was inaugurated on the 20th ult., the mayor and city solicitor striking the first blow with a pick and shovel.

At a meeting of the taxable inhabitants of West Troy, N. Y., held on the 20th ult., it was voted by an almost unanimous vote, that the water works company was entitled to $7,000 per year for 85 hydrants for four years.

The south branch of the water works reservoir in Eden Park, Cincinnati, is to be completed next year. At all events, that is the time set at present to complete it. This work will require an outlay of from $125,000 to $150,000.

The village board of St. Johnsville, N. Y., awarded the contract for the construction of cisterns for fire department purposes to two different parties, both of whom refused to accept it. The third award was made on the 21st ult., to Archibald McLaughlin, of Fultonville N. Y., at $149.90 each, or $1,199.20 for the entire eight.

The Boston *Daily Advertiser* says; "The water board has found that the old-fashioned cast-iron pipes are more serviceable in the long run than the patent pipes composed of sheet-iron and cement, which were laid down at the time of the introduction of the Mystic water, and these latter are accordingly being replaced with the old style.

The Citizens Gas Light Co. of Hamilton, Ohio, was organized on the 22d ult., with a capital stock of $75,000. They propose to put in a bid on the 6th inst., for the supplying of gas in Hamilton, for a period of ten years, and if the contract is awarded to them they will immediately commence the erection of gas works a distance out of the city.

The city council of London, Ont., has by a narrow vote withdrawn the water works by law, which proposed to take water from the river at the foot of the city at a cost of $150,000. and it is now intended to extend the scheme to double that amount of expenditure, the object being to secure a more reliable and permanent supply of pure spring water from a source situated about three miles from the city. It is thought this scheme will be more acceptable to all concerned. The other would not have gained more than fifty votes.

The Pipe Works of Messrs. Dennis Long & Co., of Louisville, Ky., are busily engaged. They have just completed a large order of special elevator cylinder castings for Brooklyn, N. Y., and have also under contract 600 tons of cast iron pipe for the new water works at Urbana, Ohio, also for six miles of pipe for the Des-Moines, Iowa, water works extension, and a large order for both gas and water pipe for Cheyenne, Wyoming Territory. In addition to the above they also have large orders from the following places in the south and west. Staunton, Va; Mt. Pleasant, Iowa; Zanesville and Dayton, Ohio; Denver, Colorado; Freeport, Alton and Rock Island, Illinois; Columbus and Terre Haute, Indiana; Memphis and Chattanooga, Tenn; Pine Bluff, Arkansas, and New Orleans, Louisiana.

The Board of Public Works of Milwaukee, last week completed the specifications on which bidders for the work of furnishing the pumping engines for the new water station on the West Side may base their estimates. The following are among the requirements demanded: The engine is to be a horizontal double cylinder engine, to have pumps of a sufficient capacity to raise 50,000 gallons of water in 24 hours, through an 8-in. pipe 3,000 feet long, under a pressure of 75 pounds per square inch. The engine and pumps must be designed so as to work easily and safely, when raising not to exceed the rate of 50,000 gallons of water in 24 hours under the same conditions. The suction main to supply the pumps is 12 inches in diameter, and the pressure in it when the engine is not working will vary from 10 to 20 pounds. The engine, boiler, and all the appurtenances are to be erected complete and ready for use on or before the 15th of December, 1877. It is said that the authorities will favor the erection of a standpipe of the Holly pattern.

MISCELLANEOUS.

The corporation of Zanesville, Ohio, has ordered $15,000 to be expended on the streets, thus giving employment to many laborers.

The expenses of the street department of New Haven, Conn., for the month of July last, were $6,711.72, of which amount $953.87 was for sewerage.

A raft of 180 spars valued at $20,000, cut at London, Canada, in June, floated on the lakes to Oswego, thence to Troy and down the Hudson, has been safely towed to Boston, saving $8000 freight.

The new Edison telephone was tested last Saturday at the Western Union Building in New York, over the extraordinary distance of 240 miles. The wire used was a loop to Hartford, Conn., and back, over which music was transmitted distinctly.

At a recent meeting of the City Council of Louisville, Ky., R. T. Scowden, the City Engineer, introduced ordinances which embody valuable improvements in the construction of streets, alleys and gutters, and of which the Louisville *Courier-Journal* says: "One feature deserves special mention. Gutters formerly have been made from block stone laid on their ends instead of on their natural beds, and as our limestones are soft, friable and seamy, they absorb moisture freely, when the action of heat and frost soon destroys the stone, so that it is a mere matter of time when our old block-stone gutters and alleys decompose and require re-construction. This has been a source of heavy cost to the city. To overcome this difficulty Mr. Scowden proposes to construct gutters hereafter, made of flagging, laid on their natural beds, from 3 to 4 feet long and from 12 to 18 inches wide, dressed smooth on top, with close, square joints. Gutters thus made will better resist the action of heat and cold, be firmer in their beds, will be smooth, drain readily, and be far less expensive to clean. Besides, by the new plan the gutters will conform to the general contour of the street, with only a slight inclination at the curb, which will devote the whole street surface to traffic, without the danger, annoyance and offensiveness which the old valley gutter produces."

OUR RAILROADS AND THEIR ECONOMICAL USE.

IV.

It is probable that the actual value of the farms and manufactories in the foregoing statement was more nearly twice the amount therein given, as in many states, the valuation of real estate was that of ten years previous, and the full value of property except cash, is not usually given for taxation purposes. From the table it will be seen that New York is first, Pennsylvania second, Ohio third, Massachusetts fourth, Illinois fifth, Missouri sixth, and Indiana seventh, and they are the only ones which have a valuation exceeding one billion. The major portion of the wealth of the western states in 1871, was in farm-lands and implements, the capital employed in manufactures and banking being greater in the Eastern states. The distribution of the banking capital at that time will give some index of the relative business and surplus wealth of the various sections of the country, which aside from $377,573,393 of greenbacks, was distributed as follows to-wit:

BANKS IN THE UNITED STATES DECEMBER, 1871.

States and Territories.	No. of Banks.	Amount of Capital.
Maine	68	$ 9,670,000
New Hampshire	47	5,294,000
Vermont	41	7,910,012
Massachusetts	208	88,572,000
Rhode Island	77	23,453,480
Connecticut	93	27,666,820
New York	360	135,855,411
New Jersey	65	14,080,475
Pennsylvania	221	56,732,930
Maryland	42	17,570,466
Delaware	16	1,308,185
District of Columbia	5	1,929,000
Virginia	35	5,713,000
West Virginia	25	3,571,000
Ohio	135	25,699,700
Indiana	78	15,280,000
Illinois	131	20,558,000
Michigan	76	8,335,800
Wisconsin	59	4,140,000
Iowa	65	5,572,750
Minnesota	24	2,532,025
Kansas	16	1,700,000
Missouri	89	22,244,100
Kentucky	84	21,540,840
Tennessee	89	4,891,300
Louisiana	17	10,555,500
Mississippi	3	400,000
Nebraska	8	895,000
Colorado	4	400,000
Georgia	22	11,211,400
North Carolina	12	1,887,000
South Carolina	15	4,695,460
Alabama	13	2,216,275
Nevada	1	250,000
Oregon	1	250,000
Texas	7	1,250,000
Arkansas	2	200,000
Utah	2	350,000
Montana	1	100,000
Idaho	1	100,000
Wyoming	1	75,000
New Mexico	1	150,000
Gold Banks.		
Massachusetts	1	300,000
California	9	8,550,000
Total	2,210	$574,656,959

Of this number 1,786 were National banks with a combined capital of $463,818,600, and 424 were state banks, with a capital of $110,838,359. From the preceding table we see New York is first, Massachusetts second, Pennsylvania third, Connecticut fourth, Ohio fifth, Rhode Island sixth, Missouri seventh, Kentucky eighth, Illinois ninth, and Maryland tenth, in their banking capital. Railroad construction in the West was far more rapid at this time than in the East, yet it was obliged to borrow most of the capital for the improvements; the negotiations being principally through some New York house, which in turn usually negotiated the loans abroad.

In nearly every enterprise non-resident officers and directors formed a part of the organization, and in order to make these investments pay, charged what seemed exorbitant rates for transportation. The growing West appreciating at first the great advantages of a railway system of communication did not in her state charters, impose many restrictions upon the rapidly increasing railways, relying more upon the competition which would naturally arise to regulate them, than upon legislation. Promises made to communities by railroad officials in securing new lines, were not carried out, because sometimes impossible and at other times for want of good faith; higher prices were charged for transportation than agreed upon or expected; railway officials wished to make their lines pay expenses, besides dividends upon heavy construction and large stock accounts. Business was not diverted from old channels as much as expected, consequently there was a disappointment on both sides, and the feeling instead of being harmonious between the people and the railroads was far otherwise. The granger movement spread through the West with great rapidity, and the cry of anti-railroad monopoly extended far and wide.

The effects were not confined to our country alone; foreign bondholders read with alarm that the state legislatures would impose restrictions upon the railways, and as early as 1871 and 1872, railway bonds of new enterprises were taken with great caution, if at all. This checked such negotiations and was the inception of the panic, for our bankers were unable to carry them longer than 1873.

Although not directly connected with the railways, yet we cannot overlook the effect upon the business of the country, of the great fires of Chicago and Boston, in which not less than $500,000,000 were destroyed, which vast amount of wealth could not be taken away from the ordinary business channels, without its being very seriously felt.

Having now called attention to the principal forces which have been in operation since railroad construction began, it will only be necessary to trace out their effects more fully in order to see what may be done to improve our railways, and all the business connected with them. In times of great distress we have not that patience at first necessary to bear, or even consider the situation with equanimity. If we are the victims of misplaced confidence, we only consider that the ones who made us the victims, are to blame, and we not in the least. Every one else is wrong, but we are right. This can only be a free country when we recognize equal rights to all. The extent of our country is so great, so varied in its topography, its climate, its agricultural productions and its mineral resources, that from the very nature of the case we have great diversity of employment. We have farmers, miners of coal, iron ore, copper, gold and silver, and of the other useful metals; then, those who separate the metals from the ores, manufacturers of all kinds of products, and finally those who transport them, and we cannot ignore any one, as all are necessary and essential for our greatest good and advancement. We only prosper, and gain in wealth, by a general advancement of the whole body politic. Live and let live is a maxim, which must extend through all of our business relations. It is the vague ideas and the want of definite knowledge, between the various branches of trade, which causes and creates so much uneasiness in others, from the idea that some branch which forms a link in the great chain of business is making more than its proper share of the profits.

In the business of transportation, therefore, through which it has only been possible for many others to thrive or even exist, it is not strange that it should be considered the most oppressive of the various branches of business. As railroad men have very vague ideas about the cost of transportation, they must not blame men in other branches of business for having views equally as crude.

Written for "Engineering News."

THE METRIC DISCUSSION.

I. LEGISLATION.

By way of supplement to the articles already published on the metric system of weights and measures, the following is a discussion of some of the objections which have been made to its introduction.

The one valid and powerful argument in opposition is, that to make the proposed change (or any other such change), will be a great annoyance and a great expense. There is no denying that it may be, however, that the probable difficulty and expense have been considerably over-estimated by opponents; it may be claimed, also, that the introduction of the metric system will be worth all that it will cost and a great deal more; and thirdly, it has been proposed to appeal to Congress for the legislation which should result in a simultaneous and concerted movement from the old weights and measures to the new, thereby making much less trouble than we shall have if we go on for a long term of years using both measures side by side. This last suggestion has called forth a vigorous protest; we are told that it would be tyrannical, entirely contrary to the spirit of our free institutions, for Congress to pass a law requiring people to use the metric system, and abolishing our old standards. If such a law were to be passed to-day and take effect immediately, it would be in appearance despotic, and in reality a dead letter; but there is no occasion for alarm on that score. If in 1880 or 1885 there shall be a universal demand for a change of standard, and Congress shall then enact, that, after the 1st day of January 1890, the metric standards in the Office of Weights and Measures at Washington, shall be the sole authorized public standards of weights and measures, that may not seem so preposterous.

People who are anxious to resist arbitrary enactments are recommended to give their attention to existing laws. It is the present policy of the law to establish particular standards of weights and measures, and to forbid under penalty the use of other standards. To learn how such legislation is liable to be applied, consult vol. 109 Massachusetts Reports page 220, Sawyer, Administrator *vs.* Smith. The suit was brought to recover the price of hay sold by weight, but "weighed upon private scales, selected by the seller, and not provided for by the buyer, and which had not been adjusted and sealed by any sealer of weights and measures as required by the General Statutes, c. 51, §§ 11 and 12.

"A sale by such scales was in direct violation of the General Statutes, c. 51, § 16.

"The decisions are uniform, that if a sale is made in contravention of a statute passed for the protection of the buyer, no action can be maintained for the price of the goods sold."

Section 16 above referred to provides that, "Whoever sells by any other weights, measures, scales, beams, or balances, than those which have been sealed as before provided, shall forfeit a sum not exceeding twenty dollars for each offense;" etc.

It is not necessary to multiply illustrations of this sort of legislation. Probably similar examples are to be found in the laws of the other states of the Union. They are, of course, especially directed against the use of false weights and measures; not so much against foreign or entirely new systems, as against something which might pretend to be a bushel and really be less than a bushel, etc., etc.; but it is sufficiently evident that under these laws there would be additional difficulty in enforcing a contract, if the contract were expressed in Chinese or other foreign measures. To that extent, at least, they interfere with individual liberty for the sake of public convenience. By their terms they appear directly to forbid the use of standards, other than those specified. Congress enacted in 1866. "That from and after the passage of this act, it shall be lawful throughout the United States of America to employ the weights and measures of the Metric System, and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection, because the weights or measures expressed or referred to therein are weights or measures of the Metric System." The Governor of Massachusetts, in the Annual Address at the opening of the Legislature Jan. 4 1877, referred to this law and to the convenience of the metric system and said:

"The Statutes of Massachusetts (chap. 51, sec. 1), prescribe what weights and measures only shall be lawful in this Commonwealth, and do not include the metric system. It is therefore thought expedient to inquire whether our statutes are in conflict with the national constitution or laws, and whether the metric system should not be included in the weights and measures which are prescribed by our statutes to be lawful."

In accordance with this suggestion the Legislature passed a law (published in the Boston Daily *Advertiser*, March 17, 1877), similar to the law of Congress of 1866. It also provides for furnishing copies of the metric standards to the cities and shire towns, and for sealing metric weights and measures, and it repeals all acts or parts of acts inconsistent with itself.

This naturally leads us to consider the relation of

Congress to the several states in this matter. The Constitution provides that "Congress shall have power," "to coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures." Congress promptly adopted a new coinage, which is very acceptable to us now; though at first it probably met with an opposition similar to that which now impedes the advance of the metric system. A very cautious policy has been adopted with regard to the power of fixing the standard of weights and measures. Judge Story says in his Commentaries on the Constitution (1833); "Hitherto, however, it has remained a dormant power, from the many difficulties attendant upon the subject, although it has been repeatedly brought to the attention of Congress, in most elaborate reports. Until Congress shall fix a standard, the understanding seems to be that the states possess the power to fix their own weights and measures; or, at least, the existing standards at the adoption of the constitution remain in full force."

Now that Congress has acted, the state governments are not going to resist. It should be noticed, however, that to give any living force to the law, the concurrent action of the states is necessary, as is well illustrated by the recent action of the Massachusetts Legislature; for the whole matter of sealing weights and measures and enforcing conformity to the authorized standards now rests with the state and municipal authorities.

Another point of interest with regard to past legislation is that ancient weights and measures have repeatedly been abolished by law. In Massachusetts the legal ton is only 2000 pounds; and Massachusetts coal dealers are perfectly willing to sell by it; (they buy in Pennsylvania 2,240 pounds to the ton, and claim that they sell at about the same price *per ton* at which they buy). The old ale quart has been outlawed in Massachusetts; and the docility with which milkmen submitted to the substitution of the smaller wine quart about twenty years ago is worthy of universal imitation; they did not alter the price at which they sold milk. There remain the dry quart and the liquid quart which differ materially; but in England both have been abolished and the British Imperial measure substituted. Our Canadian neighbors are about making the same change. Possibly some gentlemen who oppose any further metric legislation would look on complacently at the legal extinction of the troy pound, which weighs less than the avoirdupois pound, while the troy ounce weighs more than the avoirdupois ounce. When the Government begins to carry 15 grammes of postal matter for 3 cents, instead of 14 17-100 grains (as at present), the people will probably submit.

We return from this long legal digression with the conviction that there are now too many standards authorized in this country. General attention is invited to this fact, and it is believed that intelligent public opinion will demand the ultimate suppression of either the English or the Metric weights and measures; (and it won't be the Metric). Let the voice of the people be expressed through the mouths of their representatives in Congress. Popular agitation, unless concentrated upon Washington and crystalized into government action, will be comparatively ineffectual. Some school children may be taught the metric system in Boston, a colony of immigrants who have been familiar with it in Europe, may land in New York, a new engineering work giving metric equivalents may be published in Chicago, and a popular lecture by a professional chemist may awaken interest in San Francisco; each unknown and unaffected by the others. Such influences will spread more widely every day, and finally become irresistible; but how much more economical it would be if the energies already aroused could be made to work together. On the other hand Congressional action without popular support would be entirely ineffectual, as the legal tender act is now in California, where nothing but gold passes current. Any one who is really desirous to labor for reform in weights and measures can find a plenty to do, even if he is not willing to ask Congress for what he wants. The work required is to familiarize the whole American people (beginning with one's self) with the metric system.

The lake survey party who have been at work in Toledo Bay, have concluded their work. The Mississippi river will be the scene of their future labors.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 76th regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on Tuesday, September 4th, President W. Sooy Smith in the Chair.

Members present were: Gen W. Sooy Smith, E. L. Chesbrough, L. P. Morehouse, S. S. Greeley, B. Williams, Jas. R. Willett, Frederick W. Clarke, D. C. Cregier, L. E. Cooley, C. W. Durham, E. L. Billings, John W. Weston, W. S. McHarg.

New member proposed: Mr. Cuthbert Laing.

The minutes of the last meeting having been printed with the proceedings of the Annual meeting, the reading of them was omitted.

The President took occasion to thank the members for his election and in the course of his remarks pronounced a fitting eulogium on his predecessor Mr. E. S. Chesbrough.

The secretary reported the following donations:

From Mr. E. S. Chesbrough—Sewerage of Boston and the Eighth Annual Report of the State Board of Health of Massachusetts.

Mr. Gottsleben—Vienna. Studies of the Superstructure of railway construction in the United States.

Geo. T. Balch, C. E.,—General Classification of Railway Rights, Realties and Personalties.

The paper for the evening entitled "Application of the Equilibrium Polygon to Determine the Reaction at the Supports of Roof Trusses," was read by James R. Willett.

The Committee reported the following paper for the October meeting: "A Method of Survey to Indicate Direction and Speed of Current in Rivers," by S. T. Emerson, St. Louis, Mo.

After the transaction of further business the meeting adjourned until October.

ON THE FAILURE OF THE ASHTABULA BRIDGE.*

(*Concluded from page 232.*)

3°.—The Manufacture.—However carefully designed a structure may be, if the workmanship is of a poor or defective character, the parts are not in a condition to perform their proper duty. Incorrect lengths, poor joints, bad riveting and welded connections are only a few of the faults that can be laid to the manufacture. There is one class of faults which should, perhaps, be divided with the design; that is, such forms in the original design as cannot be properly made.

4°.—The Erection.—A bridge that has been designed and manufactured properly, may afterwards be so badly erected that its parts are not in a proper condition to do their duty. If the workmen are allowed to change the lengths and fittings, by chipping and filing of pinholes and abutting surfaces, by gouging the rivet holes, heating and drawing out bars, and other improper practices, to "make things come together," all previous care has been labor lost. Also by carelessness in marking, or want of proper instruction, pieces may be put into the wrong positions.

5°.—The treatment after completion.—Iron bridges—being structures formed of numerous parts held together by pins, rivets and friction of surfaces—require a certain amount of care to keep all parts in a proper condition. Nuts will work loose, rivets break, etc., minor points which may by neglect lead to greater troubles. The best of iron bridges need some care, and when we come to bridges which have faults of design or workmanship, a much more careful watch is needed over the weak or doubtful points. Many bridges have adjustable pieces upon the proper condition of which depends the adjustment of the bridge. Upon the proper condition of the counter-rods especially does, the proper action of the trusses depend. Unfortunately no method of fixing the lengths of these rods unalterably, after the bridge is adjusted, has been adopted; and equally unfortunate is it, that those who have charge of bridges imagine the panacea for all ills of bridges is to screw up the counter-rods, thus introducing internal strains into the structure, relieving some parts from strain and increasing the strain upon others. In some particular styles of bridges, this is an especial source of danger.

* Discussion by the American Society of Civil Engineers.

I have noted the above points to illustrate the fact, that the strength and condition of our bridges cannot be determined by overhauling the strain sheets solely. Their weak points should be determined by a thorough examination in reference to all the foregoing heads.

I think much error upon the subject of the safety of bridges arises from the false idea in regard to the factor of safety. It is generally claimed, that our bridges have a factor of safety from 4 to 6, whereas they have more generally a factor of safety of 1½ to 2. A confusion has been made between the factor of safety of the material and that of the bridge. A skeleton structure of any kind is formed of pieces combined to act together in support of a load; the strain upon each piece is dependent upon its length and position relative to the others, and all the parts are assumed to elongate and compress proportionately to the strain coming upon each. Should any one piece take a permanent elongation, the condition of the strains is changed and they necessarily must be excessive upon certain parts. Now, for a practical material, I do not think we can claim over 20,000 to 22,000 pounds per square inch, as the limit of elasticity of wrought iron. This, therefore, is, the limiting strain to which our structures should be considered as confined, and to which we must refer for the factor of safety of built structures.

Most of our iron railroad bridges are computed to have a strain of 10,000 pounds per square inch upon their parts when under their assumed maximum load, which is usually taken as the greatest load from the rolling stock in use upon the road, equally distributed upon both rails, but does not usually allow for the additional strains produced by this same load passing at a high speed, and subject to oscillations and shocks from imperfections of the track and rolling stock. Considered, then, under practical conditions, many of our bridges undoubtedly have strains exceeding 10,000 pounds per square inch at times; so that a factor of safety of 1½ to 2 is all that should be claimed for them. By appreciating the smallness of the factor of safety, the necessity of keeping them in good order would become more apparent to all in charge of such structures. Too many of those having charge of bridges, and some of those who build them, seem to have great faith that the bridges will carry five times their greatest assumed load, and therefore they have a large margin for neglect and abuse. If iron bridges are to be what they are supposed to be, and what they could be under proper management—permanent structures—a better idea in reference to their powers must be had. Because they do not break down after a dozen years' use is no evidence that they are safe or that they are in tolerably good condition.

To prevent further repetition of such accidents as occurred at Ashtabula, the exact character of every bridge, in reference to all the points mentioned, should be determined and the proper remedies applied before it is too late. A proper inspection must include the smallest details upon which the strength of the structure depends. Bridges cannot be inspected from a railroad train, nor can the faults be determined by running engines over the structure to see if it will fall. Each individual part of the structure must be examined, and the manner in which each part acts under the rolling loads. If it is found that some one part does not take its proper strain, it must be determined which other parts are taking the extra strains necessarily developed. The person who makes the inspection should be qualified to judge of each of the points before mentioned; the material, the design, the workmanship of manufacture and erection, and finally whether the structure is actually in the condition called for by theoretical results, or have certain parts more work to do than they should, through improper adjustments.

Mr. C. Shaler Smith.—It is doubtful whether any of the hypotheses hitherto advanced will fully account for the fall of this bridge. In estimating the strain on the lug of the angle-block Mr. Macdonald has omitted the friction, which, if the rear driver of the leading engine was directly over the second angle-block at the moment of failure, was $197,880 \times 0.175 \times 2 = 69,258$ pounds, and the direct pressure to be transmitted by each lug was $110,600 - 69,258 = 20,671$ pounds, or less than 4,000 pounds per square inch of shearing section, after the deduction is made for the air-hole in casting. Moreover, had this lug given way before the fall of the truss

the angle-block would have turned on the counter-brace as an axis, the entire strain would have been transferred to the three inner braces of that panel; these would have been compressed along their inner edges, and failure would have resulted from their lateral flexure *outwards*, while the remaining lug would have been twisted off by the turning of the angle-block under this action of the adjacent members. The other lug appears to have been unbroken, however, and Mr. Philbrick's sketch shows that the braces doubled inwardly, not outwards. This, with the fact that the chord members of that panel show lateral bending only, is clear evidence that the braces were bent, and probably the lug broken, during the fall of the bridge.

From the sketch referred to, it appears certain that the three eastern panels fell to the south, as well as joint 12 at the southwest end, the rest of the bridge falling north. This shows that the failure was not due to local crippling, but to some cause which effected the entire structure, and indicates that the lateral and vertical connections are the points to be considered. But all points connected by vertical laterals fell in pairs and in the same direction, therefore these were not in fault. The examination is now narrowed down to the horizontal laterals or wind braces. Here we find that all points connected by this systen fell together, except joints 3 and 5, in which case 5 fell to the north and 3 to the south, showing that the wind bracing connecting them was broken prior to the fall, so as to admit of the joints moving in opposite directions. This gives a clue to the mode of failure. The train being on the south truss, deflected it below the truss on the north (which bore but 14 per cent. of the load), and consequently all the vertical laterals in the joints, from 3 to 11, were loose leaving the top chord of the south truss to be held in place by the horizontal rods only. A wind pressure of 18 pounds per square foot on the truss and train would break the splice in the rod leading from 1 to 3, which Mr. Philbrick describes, and the parting of the rod from 3 to 5 would immediately follow. Joint 3, would move outwards, propagating a lateral bending wave along the chord, which would continue until a point was reached where the vertical laterals were taut. This point was joint 13, where the deflection was a minimum and the "*snap*" of the wave would come at the nearest unprotected point to joint 13,—to wit, joint 12, where there were neither vertical or horizontal rods to hold it in place. At the moment of failure, joint 12, being the middle of the wave, would move outwards, while the joints on either side would move in the opposite direction. This action would cause the end angle-block, 13, south chord, to twist to the northeast, and the main braces would slide off it sideways to the north, leaving the angle-block free to be driven down the vertical ties, by the live load, during the fall. During this action of the top chord, the second set of braces would double inwardly, just as shown in the sketch. The "snap" at the end of a wave action, caused by lateral flexure, will be readily understood by any member who had occasion to destroy a bridge during the late war, and who noted its mode of falling, according to the part of the truss selected for destruction.

One fact to be especially noticed, in connection with this accident, is the exactness with which the behavior of the material has sustained the correctness of the modern forms of the Rankine formula. When the structure was first erected, the flanges of the braces were placed in a vertical position. With the striking of the blocking, came the extension of the lower chord, the compression of the upper chord and the consequent motion of the angle-blocks, in top and bottom chords, away from each other. If the angle-blocks were square to the braces before the span was swung, they certainly were not so afterwards, and the beams were therefore compressed on opposite edges of their flanges by the upper and lower angle-blocks, against which they rested. The formula for an I beam strut, loaded diagonally on the flanges, is

$$\frac{38\,500}{1+\left\{\frac{l^2}{6\,130\times r^2}\right\}}=S$$

and substituting the values of l^2 and r^2 for the struts in question, we have

$$\frac{38\,500}{1+\left\{\frac{67\,500}{6\,130\times 0.835}\right\}}$$

$=2,711$ pounds ber square inch; or for each beam, $2,711\times 9.6=26,025$ pounds.

It appears, however, that they *did* fail, when the span was first swung off, with about 24,500 pounds per beam. When they were turned, so that their webs were vertical, and the flanges presumably square to the angle-blocks, the formula became

$$S=\frac{38\,500}{1+\left\{\frac{67\,500}{25\,000\times 0.835}\right\}}$$

$=9,100$ pounds per square inch.

Flexure of the chord or turning of the angle-blocks, so that one half of the braces in any of the four end panels would receive the entire load, would at once produce failure, as the ordinary strain on these beams, when the load was equally divided, was about 4,600 pounds per square inch when the drivers were immediately over the panel under consideration. In panel 13, of the top chord, there was a similar state of things. The three I beams, which took the strain of the main braces, were separated from each other by two beams, parallel with and between them, but which had no steadying longitudinal strain upon them, whatever. The middle beam of the three was so held, that the formula gives it a value of 21,000 pounds per square inch; but the two outer beams were 22 feet between adequate lateral supports, and consequently their strength did not exceed that of the braces, or 9,100 pounds per square inch. A lateral flexure of 1½ inches at joint 12, would produce a strain of over 10,000 pounds per square inch in one or the other of the outer beams, according to the direction of the flexure, and failure at the joint would inevitably result. In the other chord panels, all the members were under strain, and there were no loose, unstrained beams lying between and separating the working members, so it is probable that elsewhere the three inner chord beams were all nearly up to their theoretical value of 21,000 pounds per square inch.

In considering both chords and braces, the effects of the floor beams on the one and counter-brace clamps on the other have been left out, as, their action being uncertain, they have no place in rigid theory.

To conclude this part of the subject, Mr. Clark's assertion, that any iron bridge expert would have "condemned the structure on sight," is most emphatically correct. An inspection by an engineer of this class would have been followed by riveting cover plates of boiler iron on top of both chords and braces, and the addition of another system of lateral bracing, when the Ashtabula bridge would have been good for half a century to come.

Mr. Macdonald does scant justice to the iron bridge building of former times, in his remarks concerning the extent of knowledge on the subject twelve years since. Prior to the war—from Louisville, Baltimore and Richmond, as centres—a large number of iron bridges were constructed in the States of Kentucky, Maryland, Virginia, North Carolina, Tennessee and Mississippi. Many of these were important works and of excellent design. Excepting the material in compression, which is cast-iron, I know of no better bridge in the country to-day than the one over the Elizabeth river at Norfolk, Va. Following these, many more were built along the Illinois Central and other Western railroads by the Detroit Bridge & Iron Works; while at the time that the Ashtabula bridge was under consideration, Mr. Linville had already finished his magnificent span at Steubenville, and the designs for several of the great bridges of the West had taken form and shape. Mr. Macdonald's view of the case is correct so far as New York and New England are concerned, but his remarks are not applicable to the border states, Pennsylvania and the Northwest.

Concerning the lesson to be learned from this particular bridge failure, in a mechanical sense I see none, whatever. The construction of the truss violated every canon of our standard practice, and its failure has taught us nothing that we did not know before, except, perhaps, that it is possible for a bridge with a factor of safety of 1⅓ to last for eleven years.

While on this part of the subject, I desire to call attention to a dangerous practice on the part of railroad companies, *i. e.*, that of having their iron bridges under the charge of the Road Department. The "Master of Bridges and Buildings," does very well so long as the railroad is furnished with Howe trusses; but when these are replaced by iron, they should be under the charge of men who understand them, and who report to the chief engineer only. In addition to this, the bridges should be inspected twice a year, as Mr. Macdonald suggests, by an outside expert of known ability and experience.

Concerning the law proposed by Messrs. Adams and Garfield, it is an excellent one, and is probably as far as the United States government can constitutionally go in this direction. Railroads are not navigable waters, and consequently not under the the direct jurisdiction of the national legislature. A mandatory law, such as has been suggested by Mr. Clarke, would have to be enacted by the several State governments. I should amend Mr. Garfield's law, however, by changing the composition of the Board to one Engineer officer, one Civil Engineer who should be a known expert, and one officer from the Ordnance Corps.

In concluding this subject, permit me to call the attention of the Society to the fact, that in 1874, Capt Eads, Col. Flad, and myself foresaw the present state of affairs; and in the report published in the Transactions for May, 1875, strenuously urged that a law should be drafted at once covering the question of "bridge accidents," and during the following winter pressed through the various State legislatures by the individual members. Had this been done at that time, it is more than probable—as our Ohio members are both active and influential—that the Ashtabula bridge would have been condemned and made safe, and the horrors of that fatal night averted.

Finally, to fix conclusively where the responsibility of the policy of non-action in this matter is to be born, I move the adoption of the following resolution:

Resolved—that a committee of five, whose names shall be selected by letter ballot, shall be appointed to draft a law covering the points outlined on pages 125, 126, 127 and 128, of Transactions, May, 1875, adding thereto the necessary provisions to secure the inspection by experts of all questionable bridges now in existence.

And further, that this law, so drafted, shall be submitted, together with a resolution recommending its adoption by the various State legislatures, to this Society for letter ballot; and, if approved, that printed copies of the said law and the accompanying resolution be sent to members of the Society, with a request "that they move actively—each in his own State—towards procuring the passage of the specified law by the various State legislatures during the coming winter.

This action on the part of the Society will in no wise clash with the Garfield Commission. It will simply cover ground that the latter, owing to want of constitutional authority, cannot do, and will pave the way for the suppression of existing man-traps, numbers of which are doubtless known to the experts among our members.

I cannot conclude without expressing my thanks to Messrs. Macdonald and Philbrick for the public and professional spirit they have shown in this matter. The sketch contributed by Mr. Philbrick is exceedingly valuable in this connection.

Mr. W. Milnor Roberts.—One of the important lessons to be learned from this bridge accident, and from every serious railroad disaster, is that it is to the interest of companies, as well as of the general public, that only experienced, competent men should be employed—not only in locating, planning and constructing, but in superintending the road and its structures, and in managing the running department.

The precise immediate cause, or causes, of the terrible accident at the Ashtabula bridge may or may not ever be clearly defined. That there was faulty construction, judged by the bridge experience of the present day, Mr. Macdonald has shown. On the other hand, eleven years of very heavy and annually increasing heavy use of the bridge might imply that the bridge was sufficient for the business when it was built, and that there may have been some particular cause, independently of any fault of construction, without which the bridge might possibly have continued to carry such heavy traffic safely for some years longer.

Mr. Charles Hilton has stated that there is a railway station only about 1,200 feet west of the bridge, and that the locomotive engineers were in the habit of be-

ginning to apply the brakes, on the westward bound trains, near to and on this bridge. Such a circumstance, in this connection, is certainly deserving of special attention, as offering a possible clue to one of the immediate causes of the destruction of the bridge. A bridge (with or without a comparatively weak spot in its original construction), subject to frequent, unusual, extraordinary and irregular strains, not provided for, would of course be more liable to injury and to ultimate destruction in consequence.

The tendency of the discussion appeared to show that the bridge had a weak spot, but refused to break in that place, and broke where, according to the calculations, it may have been strong enough to stand the usual tests of the regular transit of trains. In the absence of knowledge as to the immediate cause of the disaster, there seems to be here an element of uncertainty running into the scientific treatment of the question.

Railroad companies are, and should of course, feel deeply interested in securing every safeguard against accidents; for, next to the unfortunate individual sufferers and their families, the companies, pecuniarily and otherwise, are most interested in preventing such; but, in the few remarks now to be made, it is not my purpose to criticise the officers or employees who may have been regarded as the custodians of the Ashtabula bridge. Nevertheless, having been invited to consider "the most important lessons to be learned from the event," I am willing to add my mite in that direction, based upon long and varied experience.

Accidents, serious accidents, will continue to occur in the use of railroads, on bridges and elsewhere, even where apparently all proper provision has been made to guard against them. Trains may become deranged, from broken wheels or axles, or derailment, on bridges strong enough for regular use, yet which may not be sufficient to withstand the extraordinary, sudden shock. It is well known, also, that during the past eleven years, the weight of locomotives and the weight of their trains have been gradually increasing on all our first class roads, and it has been and is the duty of those in charge of such roads to see that their bridges are correspondingly strengthened. It is folly to fancy that a 25-ton locomotive, drawing a train of 25 cars at the rate of 10 miles an hour, tries a bridge like a locomotive of 40 tons, drawing a train of 40 cars at 15 miles an hour; and yet some such change as this rough example would indicate has been going on in the use of our railroads, and it is to be feared, without in all cases due attention to the fact.

There is hardly an excuse now for building an iron or steel bridge of inadequate strength; that is to say, of less than the strength computed, and which it is designed to bear, and it would seem that there have been enough accidents to prove the importance of having such bridges planned and built by bridge experts — by men whose lives and talents are devoted especially to this particular sort of structure, and whose duty it is to know that all the parts are properly proportioned and of the best material, and whose interest it assuredly is to put up structures which will not fail. I think that this is one of the important lessons to be learned.

In regard to the general subject of railroad accidents, and especially touching the Bill presented by Hon. James A. Garfield, in the House of Representatives, January 31st, it is difficult to say in advance precisely what effect the action of such a commission would have in connection with railroad accidents, for or against them.

The Commission is to "inquire" into the number, causes and means of prevention of accidents. The first duty is merely clerical; the second involves an indefinite series of difficult and complicated investigations, scattered over 80,000 miles of railroads; the third "to inquire into the means of prevention of accidents," implies or should imply vast practical knowledge and long experience in the construction and management of railroads and of their thousand appliances.

Next, the three Commissioners are to investigate such accidents on railroads as may, in their judgment, be accompanied by "circumstances of an unusual or unexplained character." They are also to submit special reports, and at the close of each year a general report, upon the subject of accidents — all to be submitted to the Secretary of the Treasury and to Congress.

The Bill, as it stands, is to establish a *Bureau of Railroad Accidents;* partly statistical and partly for the collection and discussion of causes and of means of prevention; "the Commissioners to be Engineer Officers of the Army." By implication — as these Commissioners are to receive compensation for actual travel and other necessary expenses — they are expected to visit in person the scenes of accidents, after they have learned of their occurrences and, as the number of railroad accidents in the United States in a single month is fearful, constant travel on their part would only permit them to attend as a coroner's jury upon a few.

Members of this Society can only offer their individual views upon the merits of this Bill. It is an experiment, and possibly, but not probably, it might drift into something of practical utility, provided the Commissioners should be experienced in railroad affairs. But I fail to trace any natural connection between railroads *per se*, and United States military engineers; while I say with great respect for United States engineers in connection with their legitimate duties—gentlemen who, probably, would not desire such an anomalous duty.

The Bill makes provision for the gathering of information and the formation, if possible, of views of the Commission, but fails to provide for any practical application, and it is at least questionable whether any advantageous practical results could ever be reached through such a Commission.

State legislatures, and Congress, from whom railroad companies may have derived their powers, have certain authority in the premises which the companies must respect, but a state or national quasi-management of the running of corporate railroads, will probably never be fairly practicable. Companies must be held responsible by the public, and legislatures and Congress must aid the public in holding them to their responsibility, but this is not likely to be aided by the intervention of a state or national officer between the company and the public. One might as well expect to see the movement of a watch improved by the intervention of a hair among the wheels.

One good working clerk, authorized to receive the railroad publications and a few daily journals, could collate the main features of railroad accidents, and arrange them in the form of a report, that would be quite as useful as the one indicated, and at less cost. The truth is, that railroad accidents will not be prevented by any such system. Many will continue to occur, because they are inherent in any railroad system run by human agencies. Engineers and railroad companies can only point out and apply, measurably, safe methods, by insisting upon first-class materials, first-class workmen, first-class superintendence and first-class management, and paying therefor a good price. The less Congress has to do with the management of running railroads, probable the better it will be for the people who use the roads.

It is a truth that railroads are liable to accidents which human prescience cannot foresee, but it is also true that many accidents are prevented by carefully improved management. Eternal vigilance, on the part of railroad managers is the price of safety.

SURVEY OF THE COURSE OF THE PO, ITALY. *

BY COMMANDER BARILARI,
Vice President of the Supreme Council of Public Works in Italy, and Inspector of Civil Engineers.

In the year 1872 great floods occurred from the river Po. The banks of the stream were broken through in many places, and a large area of country suffered heavy damage. The Italian Government, with a view of preventing the recurrence of similar disasters, appointed, early in 1873, a commission of seven members, all of whom were men of distinction among hydraulic authorities, with instructions to prepare a complete survey of the basin of the river, in order to arrive at a decision as to the most appropriate preventive measures. The first result of the appointment of this commission was the preparation of a complete section of the general course of the Po, together with the lines of its principal affluents and branches, which was completed towards the end of 1874. A Paper giving some of the results of this survey was communicated by the Author to the Italian Royal Academy, in December 1876, and forms the subject-matter of this article.

The Author remarks that the rainfall of the year 1872 was so extraordinary, that the principal rivers of the Italian Peninsula burst their banks, and caused inundations, most injurious both to agriculture and to the public health. The Paduan valley was the principal scene of suffering; but the mischief was little less in the provinces of Ferrara, Mantua, and Modena, in each of which large areas of land remained for a long period submerged. The overflow of the Guarda, in the Ferrarese territory, was the first of these misfortunes, occurring in the spring of 1872; and in the autumn of the same year yet more serious disasters were experienced in the Mantuan district. While these evils menaced the right bank of the Po, its left bank, near the towns of Ostiglia and Casalmaggiore, was threatened by equal disaster, only averted by the energy and skill of the engineers.

The costs incurred for the reparation of the banks, and for the strengthening of those places where future danger was apprehended, were very heavy. In addition to the actual loss suffered by the various localities, the demand on the public exchequer was so great as to render it a matter of essential importance to provide against a recurrence of the mischief. The Government, recognizing the urgency of the case, appointed the commission above mentioned, of which the venerable Senator Lombardini, who is termed the Nestor of Italian hydraulic engineers, was named honorary president.

Fluviatile hydraulics, the Author remarks, cannot approach the stage of practical application until for every watercourse, great or small, a complete and accurate survey is made of its essential conditions, principally those of the planimetry and altimetry (or plane and longitudinal sections) of its entire course. For this reason, the Commission decided that it was necessary to have an accurate levelling made of at least that portion of the course of the Po which lies within artificial banks. A section was accordingly prepared, reaching from the sea to Moncalieri; the different mouths or branches of the river, and the principal affluents, so far as their channels were embanked, being levelled at the same time. The work was executed by the civil engineers of the respective provinces, assisted by youths detached from the "Schools of Application." By the close of 1874, the entire course of the Po had been levelled on each side of the river. Where embankments existed, the crown of the earthwork was taken; in other places the natural banks of the river were indicated as accurately as possible. A number of permanent bench-marks were made, so as to render the results of the work useful in the future.

The sections show (besides the altimetric determination of every bench-mark) the crests of the banks, the flood high-water lines, the levels of the meadows, the lowest water-levels in summer, and the maximum and mean depths of the river. The base line is taken at 32.81 feet (10 metres) below the mean sea-level of the hydrometer of Porto Levante. The sections are drawn on the scales of 1—15,000 longitudinal* and 1—200 vertical. The length of the section on the right bank is 350 miles 600 yards; that on the left bank 349 miles 441 yards. The distances are progressively numbered in kilometres, and it is intended that the publication of this very complete section, available alike for the whole course of the river and for any particular locality, shall furnish every requisite information, not only to the engineers in charge of the river, but to all students of the subject. Further, with a view to publication, the sections have been reduced to the scale of 1—50,000 longitudinal,† a considerable number of the less important dimensions being omitted in the reductions. These sections will be accompanied by:—

(1) A topographical survey of the basin of the Po, on the scale of 1—400,000.

(2) A plan, on the scale of 1—50,000, on which the course of the banks and shores has been indicated by the same engineers who conducted the general levelling.

(3) Sections of the branches and mouths of the river, and of the principal embanked affluents, as far as the influence of the back water of the Po is felt.

* From Abstracts of Papers in Foreign Transactions and Periodicals. Institution of Civil Engineers, London.

* This is equal to 1,360 feet to the inch, or a little over 4 inches to the mile.

† 4,166 feet to the inch, or about 1¼ inch to the mile.

(4) Main section of the river, on the scales of 1—400,000 longitudinal and 1—400 vertical.

(5) Eighty-nine cross sections taken between Pavia and the sea, across the embanked part of the course of the river.

(6) Above two hundred diagrams of the daily observations made on the principal hydrometers existing along the embanked portion of the river.

The Commission has not failed to examine the relative levels of the actual banks of the river and of the heights attained by the floods, the section affording palpable indication of the points where most care was required. The result of this examination has been the estimate that it was necessary to spend the sum of £600,000 in restoring and strengthening the banks, and a further sum of £320,000 in subsidiary works. The Ministers of Finance and of Public Works have given their assent to the recommendations of the Commission, and a law was passed on the 9th of July, 1876, assigning £230,000 for the execution of the first series of works, reserving those which are less urgent for further legislation.

The Po, especially during the present century, has been subject to floods progressively increasing in height. The expedient of attempting to confine these floods within the channel of the river by continual additions to the height of the artificial banks has been considered as inapplicable by the Commission, as being a method tending to increase the very dangers which it is desired to prevent. For this reason the object sought by the Commission was rather the reduction of the floods themselves, or, at all events, the arrest of their increase. This aim involved the investigation of the influence on the volume of the river of the denudation of the growth of woods on its banks; the suggestion of the legislative measures; the construction of storage basins or lakes to retain the flood water for subsequent distribution for the purposes of irrigation; the effect of diversion of effluent streams; the possibility of straightening the channel of the river; the advantage of the establishment of local ponds for the purposes of storage and reclamation; and, finally, the determination of the improvements in the mouths of the stream.

The Commission further regarded the whole question under its purely scientific aspect. They came to the conclusion that the formulæ now employed for determining the volumes of discharge of large rivers in time of floods are not to be relied on especially when the area flooded is considerable. But when careful experiments can be made on a sufficient length of straight and regular channel by determining the mean velocity at different heights of the water, commencing with the seasons of drought, the results may be regarded as sufficiently accurate for ordinary practice. To this end numerous observations were made of the mean velocities of the Po, at different levels, in two selected localities, both by floating indicators, by Woltmann's current meter, and by the reometer of Revy. From these observations the Commission arrived at satisfactory results as to the volumes of water discharged by the river from its lowest ebb to its highest floods.

The levelling, which was under the direction of Signor Barilari himself, was executed on both sides of the river, the independent sections thus obtained being checked by comparison with one another at frequent intervals. The profiles were plotted on the scale of 1—100,000, and accompanied by numerous cross sections. It is thus possible to speak with certitude as to the minute accuracy of this portion of the work.

A levelling of the course of the Bolognese Reno was effected by the engineer Brighenti in 1840, and one of the course of the Arno by the engineer Manetti, in 1850. The sections were published by care of the government then in existence in those territories. A similar and important publication, as to the river Loire, has been subsequently made in France, under the directions of M. Collin, Inspector-General of Bridges and Roads. The addition of the survey of the Po to those of the above-named rivers has been made, Signor Barilari adds, under the most fortunate auspices, as it is due not so much to the disasters of 1872 as to the establishment of the unity of Italy. The river Po, from the Alps to the sea, now belongs to Italians, and its regulation has ceased to depend on foreign domination. One authority has sanctioned the survey and the execution of the work, and one technical body has supplied all the professional service required. The law of the 9th of July, 1876, will not only render essential service to the material welfare of Italy, but will afford, by the publication of the survey, to the engineers of other countries a means of extending their knowledge.

THE RIVER THAMES.*

BY JOHN BALDRY REDMAN, M. INST. C. E.

It is not even known who constructed the embankments which now regulate the stream in the lower reaches. No one can do more than speculate as to what was the condition of the sand-banks of the estuary before these embankments were raised. The tides must have had free range over the large areas of the Essex and Kent marshes, now, ordinarily, near the river, 7 feet below the level of high water of a spring tide; and Wren, in his "Parentalia," Philosophised as to the early condition of London.

The abstraction of tidal water on either bank for 30 miles in length and for an average width of only ½ a mile on either side, by 3 feet in mean depth, would represent nearly 70,000,000 tons. The areas of the Essex and Kentish marshes on the river banks amount to about 30 square miles, and assuming 3 feet as the average tidal depth, the above is the quantity of water shut out; if the average depth were 7 feet, the amount excluded would be more than double.

The total quantity of tidal water between Teddington and Sheerness may be thus stated:—

	Miles.	Mean width. feet.	Mean range. feet.	tons.
London Bridge to Sheerness	43	× 1,500	× 15	= 142,533,482
London Bridge to Teddington	20	× 500	× 10	= 14,732,143
Gravesend to Sheerness, extra width:	16	× 4,000	× 15	= 141,428.571

As the last quantity but slightly affects the consideration, and as the outline of the river was little altered by these early works, the quantity of tidal water acting upon the river above Gravesend may be assumed to have been reduced proportionately by these early embankments. Now, on the supposition that high-water level was raised 12 inches, they would return as an equivalent, 50 × 1,200 × 1 = 8,839,285 tons. In effect about one-eighth of the volume abstracted. They must, however have returned a much larger proportion as an equivalent by the deepening of the low water channel.

If the comparison be limited to Gravesend, which is perhaps more correct, it would stand thus:—

	Miles.	Mean width. feet.	Mean. range. feet.	tons.
London Bridge to Gravesend	28	× 1,500	× 15	= 92,812,500
London Bridge to Teddington, as before				= 14,732,143
Total tidal column				= 107,544,643

Thus the quantity of water shut out by the embankments may be equal to from five-eighths to three-fourths of the present tidal column, while one-eighth of the quantity abstracted is returned by raising high water.

As regards the low water equivalent, it is impossible to hazard a conjecture of the quantity. Looking at the great depth in the several reaches, the existing course of the river was undoubtedly the low-water channel before the commencement of the embankments, whether by the Romans or the Saxons, and the great conservative agent was then, as now, the tidal wave.

UPPER REACHES.

The treatment of the upper reaches of the Thames is involved in as much obscurity as the lower reaches and estuary. So far back as history extends, the Church appears to have had the monopoly of the fisheries; monks were the residents of the fair slopes of Windsor, and it was from the Church that the Crown obtained the site, since the favorite suburban residence of our monarchs. The establishment of the first locks, weirs, and their natural adjunct the mill is in most cases unrecorded; but their names indicate their origin, and the Churchman and Crusader went hand in hand in establishing and profiting by these useful and necessary adjuncts to agriculture. The Temple Mills above Bisham and Marlow, and the Temple Mills on the river Lee, situate at the verge of the tide, had a common origin; they were both founded at the same period by the same semi-clerical and military fraternity; both were originally corn mills, subsequently copper mills; one afterwards became a paper mill, and the other has now lapsed into desuetude and unproductiveness, and is only commemorative of a regime long passed away.

The Abbey Corn Mills at Chertsey, again, show their origin in their name, and the same remark applies to those on the Channelsea, Abbey, and Mill streams, northeast of London, tributaries of the river Lee, itself a tributary of the Thames.

OLD LONDON BRIDGE.

Whilst the Church in early times was the great architect of the age, as well as mill owner, so also it was the civil engineer of the period. The first bridge across the Thames had for its author Peter of Colechurch, a monk, to supply accommodation to the numerous pilgrims passing from Southwark to London. Its history is well known, and for centuries it was the only means of communication from the south to the north side of what is now the metropolitan area, but was then the site of several towns, London, Westminster, Lambeth, etc., all situate in open country, the two last under the name of Alsatia, the refuge of the outlaw, and preserving even to the present day its peculiar identity. The fact of London bridge having been for six hundred years the only means of communication north and south has had a wonderful influence in the resultant conformation of the metropolis and the arterial means of intercourse; all the main roads north and south converging towards the bridge.

POWERS OF RIVER.

As a natural means of intercourse, and as a sanitary agent, the powers and resources of the river have been overtasked to the utmost. It has been treated in the most fickle and capricious manner, and made an instrument to fulfill the selfish purposes of those resident on its banks. At an early period it might, by a general and more comprehensive view, have been made subsidiary to the benefit of the country at large.

Various as are the duties devolving on the river, being the main drain of the metropolis, supplying potable water, tidal oscillation, and, above all, being the carrier of its colossal commerce; no less numerous are the conflicting interests which benefit thereby. The origin of the early locks is obscure; most of them were formed for isolated purposes, and the constant disputes, even now, between those possessed of abbey fishing rights and the general community are only indicative of this spirit.

COMMONS' REPORT, 1799.

The report of the House of Commons of 1799 on the rivers Isis and Thames is perhaps the first public document giving a general view of the then condition of the river. At that time, notwithstanding locks and weirs those rivers and their tributaries had arrived at such a condition as to demand legislative measures for their conservation. Numerous schemes were proposed for getting over the difficulty, not by the erection of new dams or weirs and locks, but by abandoning the neglected stream altogether, and making the river the feeder of an artificial river or canal, to shorten the journey and render more easy the navigation. Such was Brindley's scheme for a canal from Monkey Island to Boulter's Lock, happily never carried out.

OLD LONDON BRIDGE,—REMOVAL AND RESULTS.

The great result of the inquiry of 1799 was, subsequent to the formation of the large central arch, the entire removal and re-building of London Bridge; the attendant results of which were the failure of the foundations of Mylne's bridge at Blackfriars in 1836; the subsequent partial reconstruction and underpinning of the latter bridge, and the quickly following failure of Labelye's old Westminster bridge (always faulty), and similar treatment. Both were attacked by the same inveterate symptoms after their apparent renovation. At Blackfriars, ten years after the repairs, the river bed was 6 feet lower; and a similar cause produced a like result at Westminster. At the latter site, Page's elegant structure is supported upon piles and caissons carried down into the blue clay so great a depth as to promise it a fair lease; whilst at Blackfriars the late Mr. Joseph Cubitt, Vice President Inst C. E., sank wrought-iron to so great a distance to the same formation as to insure a similar long life; but there is no blinking the fact that hitherto on the Thames, as

*A Paper read before the Institution of Civil Engineers, London.

on the Tiber and Clyde, bridge engineering has been antagonistic to river conservancy, and even now the two are in direct antagonism, notoriously exemplified by the condition of the foundations of Waterloo Bridge on the Lambeth shore, with their series of broken Kentish rag stone outwork slopes upon a mud foreshore.

It was designed by Rennie before the removal of old London Bridge, and to the then contour of the bed and low water regime of the river, the present enormously altered condition of which, especially in the upper reaches, is the resultant of numerous causes. That the removal of old London Bridge was not the sole one is evidenced by the continued and progressive lowering of the river bed and of the low-water level; it was the main cause, but it was followed subsequently by numerous other active agents—the removal of old Westminister and Blackfriars bridges being the chief—the attendant results to navigation are a progressive lowering of the river bed. Added to this the systematic removal of the natural half-tide weirs, which kept back the ebb in the shape of shoals, such as the large half-tide island off Montagu House, below Westminster Bridge, which made its appearance at low water thirty years ago; and such patches at the Blackwall rocks and Daggenham shoal, which had on them only half the normal depth of the surrounding river at low water, have had an extraordinary effect, not only in developing the flood, but in accelerating the ebb; and although in cubic quantity 25 per cent. may be added due to the removal of old London Bridge, it is an open question whether this amount is not to be increased one-half, *i. e.* by 12 per c nt., or 37 per cent. in all, due to the removal of all those obstructions by the tide and the steam dredger. The result is an earlier and a longer flood, with increased altitude, and a shorter, lower, and therefore greater scouring agent on the ebb.

(*To be Continued*).

CORRESPONDENCE.

PROPELLING CANAL-LOCK GATES.

KEOKUK, IOWA, *August 30, 1877.*

Editor ENGINEERING NEWS.

SIR:—The subject of opening and shutting lock-gates being considerably discussed here, owing to the aggravating interference of drift, mud, etc., with the working of the machinery of the lower gate of the lower lock of the DesMoines Rapids Canal, it occurs to me to suggest an effective and simple means of accomplishing the opening and shutting, viz., to employ a strong jet of water through two way nozzles, to be placed permanently in the toe of the gates (and there may be other jets along the foot of the gates to clear away mud, drift, etc., in the passage of the gate) while a greater number of the nozzles playing from the opposite side of the gate would propel it in the required direction. Of course you are aware that this method is employed to propel steamboats; so power enough can thus be obtained without the use of complicated machinery.

ALEX. BLACK.

BOOK NOTICES.

NEW CONSTRUCTIONS IN GRAPHICAL STATICS. By Henry T. Eddy, New York; Published by Van Nostrand, 1877.

This work deals with arches, retaining walls and domes, principally with the first mentioned. The treatment is generally clear, although in a few instances not exactly what one could wish. There are some points that were rather difficult to follow, without devoting more time than was at our disposal.

Under the heading "Arch Rib with three joints" it is said "Variations in length due to changes of temperature induce no bending moments in this arch." This is a point well worthy of consideration and might go far to compensate for other drawbacks.

In a description of the Cincinnati Suspension bridge it is remarked that "it is really an indeterminate question as to how the load is divided between the stays and the trussing." Assuming this to be true it goes to show how an engineer's idea is not controlled by mathematical deduction, but is nevertheless successful.

The equilibrium polygon is constantly made use of, and its scope and power well exhibited. It is only lately that its power and simplicity have been appreciated.

The chapter on Retaining Walls and Abutments is particularly valuable and we think will be more readily comprehended than many other parts of the work. It is less "bookish" than they are.

The chapters on Domes are interesting. They relate to spherical domes exclusively though it is remarked that "the proposed construction applies equally to domes generated by the revolution of some curve about a vertical axis." While this is true it would require a somewhat different application. As true spherical domes are seldom, if ever built, it would have been better to have made the demonstrations apply to those forms in general use.

The work as a whole is a good one and will assist the earnest student and advance the study of Graphical Statics. It appears to be written by a teacher for his students, and will do good in that way and also to those who have a taste for Graphical Statics and desire to understand the subject.

We think however, there is yet a work needed on Graphical Statics for "practical engineers" by which term we mean engineers experienced in actual construction who have also acquired a good, general education, but who are not "up" in the higher mathematics, and, as Trautwine remarks have long forgotten any portion of the calculus they ever knew. For such men it would be better to omit all reference or exhibitions of calculus or confine them to an appendix. We are of the opinion that Graphical Statics can be made complete in itself, and it would greatly advance it among practical engineers if such a work were written. Such men will always we think form a majority of the profession. For all experience goes to show that when engineers become engrossed in actual practice they forget to a greater or less extent, simply scholastic knowledge.

There may be some exceptions to this, but as a rule it is indisputable. For after all, the calculation of strains forms but a portion and not the largest portion of their duties.

A TREATISE ON THE USE OF BELTING FOR THE TRANSMISSION OF POWER. By John H. Cooper, M. E. Philadelphia; Claxton, Remsen & Haffelfinger, 1877.

In a compact space of 300 pages the compiler of the above work has brought together about all the practical information on the subject that any manufacturer or user of belting could desire. The subject is a very important one to practical machinists, as undoubtedly there is a great waste of power, time and money constantly occurring in every shop where belts are used, through ignorance in the shaping of pulleys, in their covering, in the selection of belting, in its use and in its care, besides a multitude of other details that should be known to the superintendent, at least, of every factory in the country. We know from personal experience that a familiarity with a few of the rules given in this work would save to the average user of belts many times each year the cost of the book. We give the Index of Chapters, which will fully illustrate the character of the contents of the Treatise, and it will be observed that more than one-half the whole is given to the first chapter on "Rules and Data."

Chapter 1. Rules and Data for Belting; 2. Methods of Belt Transmission; 3. Cements, Adhesives, and Fastenings; 4. Varieties of Belting; 5. Strength of Belting Leather; 6. Experiments of Briggs and Towne on Leather Belts; 7. Experiments on the Tension of Belts, by A. Morin; 8. Rope Transmission of Power; 9. Frictional Gearing.

The paper on which the work is printed is heavy tinted, the binding is substantial, and in its entire mechanical execution Mr. Cooper is fortunate in his selection of publishers.

A TREATISE ON ENGINEERING CONSTRUCTION, embracing discussions on the principles involved, and descriptions of the material employed in Tunneling, Bridging, Canal and Road Building, etc., etc., by J. E. Shields C. E. with forty-four illustrations. New York D. Van Nostrand 1877.

The above work is really a concise epitome of the varied facts connected with Engineering Construction, combined with the general principles involved therein. Under the heads of Foundations, Masonry, Tunneling, and Engineering Geodesy, a fund of information is accumulated, which, while eminently valuable for immediate use in all minor work, serves as a guide and index to more elaborate research in the labyrinth of literature on engineering topics. Any book that saves valuable time and renders assistance in more thorough investigation by presenting, in a readily accessible form, the essential points of a subject under consideration with the latest and most practical means of solution, recommends itself at once as a worthy addition to the library.

One hundred and thirty-eight pages, interspersed with forty-four illustrations comprise the matter, and we may add that it is neat in appearance and of moderate price,—both important features.

PUBLICATIONS RECEIVED.

Journal Zodtcky. St. Petersburg.

Zeitschrift des Architekten und Ingenieur Vereins, Hanover.

Transactions American Society of Civil Engineers, for August.

Report of the Joint Special Committee on Improved Sewerage—Boston, July 1877.

Memoires et Compte Rendu des Travaux Societe des Ingenieurs Civils. Mai and Juin, 1877. Paris, 1877.

Seventh Annual Report of the Trustees of the Columbus, Ohio, Water Works for the year ending March 31st, 1877.

Extracts from foreign periodicals: *The River Thames.* By John Baldry Redman. *Stooke on the Whiston Pumping Station,* St. Helens, Lancashire. *Baldwin on Tunnel Construction. Institute of Civil Engineers,* London.

Seat of War in the East. Map of Turkey and parts adjacent; compiled and published by authority of the Honorable, the Secretary of War, in the office of the Chief of Engineers, under the direction of Brig. Gen. A. A. Humphreys. Scale 44.2 miles to an inch, June 1877.

The *Atlantic Monthly* for September, 1877. Perhaps the most valuable paper contained in this month's number is the one by David A. Wells, entitled "Are Titles and Debts, Property," which enters very fully into the subject of Taxation and to be appreciated must be read in full, and we recommend it to our readers for purchase.

"*The Metallurgical Review*" No. 1. Vol. 1, Sept. 1877, published monthly by David Williams, N. Y. at five dollars per annum.

This new candidate for the favor of scientific men, "is devoted exclusively to the literature of Metallurgy, and is intended to be a medium for the consideration and discussion of all questions of scientific interest relating to the production of the useful metals." The initial number, in the excellence of its articles by well known writers, and in the unexceptionable style of its "make-up," reflects great credit on its enterprising publisher who, we feel assured, will spare no expense in maintaining the standard of excellence with which he has started.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

A recent election in Owosso, Mich., upon the question of building a new iron bridge, resulted in a majority for the bridge.

A new bridge is proposed to be built across the Maumee river just above Toledo, Ohio, which will be 2,419 feet in length and will cost $55,000.

The Cincinnati *Daily Times* of the 29th ult., says: "The County Commissioners of this and Clermont County, at their joint meeting, yesterday, at Remington, decided to build the new bridge at Fuller's Mill across the Little Miami river, above the dam. The bridge will be of one span 280 feet, and have a roadway 18 feet wide."

The channel span of the bridge over the Ohio river, at Cincinnati, O., built by the Keystone Bridge Company for the Cincinnati and Southern Railway company, was swung clear of the false works last week. This is the largest span—520 feet—of truss bridge in the world. The upper chord is 185 feet above the ordinary water, and weighs about 1300 tons.

Work on the Severn railway bridge is being rapidly carried forward. Thirteen spans out of the twenty-one are completed, and all the piers except two, are finished, or in hand. The contractors, Messrs. Hamilton & Co., are driving the deep water works with all possible speed. As a bridge undertaking, this is the most

gigantic in England, the engineering difficulties being largely increased, owing to the shifting character of the extensive sands of the bed of the Severn.

The new iron railway bridge over the Douro, near Porto Portugal, crosses it with an arch of a single span which measures 160 meters (520 feet) and has a rise of 42 meters (138 feet 6 inches). It is crescent-shaped in form; that is, the extrados and the intrados, which are connected by struts in the form of St Andrew's cross, are farthest apart at the crown.

By reference to our advertising columns, it will be observed that the time for the receiving of proposals for the superstructure of the contemplated bridge over Rock river, at Sterling, Ill., has been extended from September 11th, to September 25th inst. Bids for the piers and abutments will be opened on the 18th inst., as per advertisement.

RAILROADS.

A narrow-gauge railroad is talked of, to run from Baltimore, Md., to Ellicott City.

Emporia, Kansas, is determined to secure the building of the K. C., E. & Southern narrow-gauge R. R. The road is evidently in a fair way to a successful issue.

R. W. Flower, Jr., who was the manager of the narrow-gauge R. R. around the Centennial grounds, has received a proposition to go to Paris and build and operate a similar road on the Exposition grounds there next year.

A railroad ballasted with silver! That is partly true of one in Nevada, over which ore trains run. Silver dust has been sprinkled along the road bed until the earth assays at $50 a ton. The gathering of this metal would cost more than it would be worth at present, but in time the accumulation will repay the trouble.

We are in daily expectation, says an English paper, of hearing of the opening of the first tramway in Rome. It is constructed between Porta del Popolo and the Ponte Molle a distance of about 2740 metres. The service will be begun with eight cars of first and second class, each of which will be drawn by one horse. Ordinarily the cars will run every ten minutes, and on *fete* days every five minutes.

The Rochester, N. Y., *Democrat* says: "The possibility has grown into a very strong probability that a railroad will be built from Penn Yan to Dresden, to connect with the Syracuse, Geneva and Corning road at that place. A company has been formed in accordance with the laws, on the basis of a capital stock of $60,000, which is divided into shares of fifty dollars each. Ten per cent. of the stock has been paid in."

Under the act of 1877, narrow-gauge roads in the State of Missouri, are only required to have a capital equal to $5,000 per mile for the proposed road, and but $500 per mile of the capital have to be subscribed, five per cent. of which latter amount has to be paid in cash to the directors before the organization is complete. Therefore, a narrow-guage road of ten miles in length can be organized with the small sum of $250 in cash.

A 3-feet gauge railroad was formally opened in Ireland the other day by the Lord-Lieutenant. This is the first passenger line in Ireland on the narrow-gauge system, and connects the flourishing inland town of Ballymena with the seaport town of Larne, from which already a daily service of steamers plies to Scotland by the shortest sea route. The line traverses one of the most fertile agricultural districts of Ulster, and one in which iron ore has recently been discovered in large quantities.

Articles of association of the Indianapolis & Sandusky R. R. company were filed on the 3d inst. with the secretary of state of Indianapolis. The road will begin at the city of Indianapolis, passing through the counties of Marion, Hancock, Hamilton, Madison, Delaware, Randolph and Jay, to the state line between Indianapolis and Ohio, at the point where the line of the Lake Erie & Louisville R. R. company will cross the state line, being a distance of 90 miles. The capital subscribed is $100.000.

Articles of association of the St. Joseph & Des Moines R. R. company (narrow-guage) were filed in the office of the secretary of state at Jefferson City, Mo., on the 28th ult. Directors: John L. Motter, James H. Pickering, W. B. Johnson, Robert Green, E. A. Garvey, Arthur Donahay. Road to be constructed from St. Joe in a northeasterly direction to or near the town or Albany, Gentry county, through the counties of Buchanan, Andrew, DeKalb, Gentry, Harrison and Worth. Length of road about 45 miles. Capital stock $225,000.

In 1840 it has been estimated that our yearly average of railroad construction was about 500 miles. In 1850 this average had increased to 1500. In 1860 it was nearly 10,000. and in 1871 it was stated that enterprises requiring an expenditure of $800,000,000, and involving the construction of 20,000 miles of railroad were in actual process of accomplishment. In 1872 the aggregate capital of the railroads of the United States, which were estimated to embrace one-half of the railroads of the civilized world, was stated to amount to the sum of $3 159,423,057, their gross revenue being $473,241,055.

The extension of the Central Branch of the Union Pacific R. R., from Greenleaf to Concordia, Kansas, is progressing very favorably, the gravelling and masonry being well umder way, and the contracts let for all material and labor. The Kansas Rolling Mill, at Rosedale, Kansas, has the contract for the iron, and a large quantity of cedar ties are being received from Chicago. Track-laying will commence about the 12th inst. The distance from Greenleaf to Concordia is 42 miles. Of this distance there will be 25 miles of nearly level line. The grading on the remaining seventeen miles will average about 9,000 yards to the mile. The Republican river will be crossed at Clyde, with a "Pratt" combination bridge of three spans of 150 feet each, for which the Missouri Valley Bridge Co., of Leavenworth, Kansas, have the contract. The substructure will be of wrought iron cylinders, piling and concrete.

GAS AND WATER-WORKS.

Rochelle, Ill., is discussing the subject of water works.

Honston, Texas, has no drinking water not brought over a long road in carts.

The new water works at La Crosse, Wis., are approaching completion.

The ratepayers of Peterborough, Ont., have decided against water works by a vote of 319 to 43.

Paris, Ill., is stated to be at sea regarding the water works question, and will hardly build this year, if at all.

A by-law, to establish water works, was defeated in Brussels, Ont., on the 30th ult., by a majority of thirty-ty-three.

The City Engineer of London, Ont., is hard at work with the plans and specifications for the proposed water-works scheme for that city.

Keokak, Iowa, is looking for more subscribers to the capital stock of the water company, and must have the same before work is commenced.

The cost of the artesian well in Douglas Park, Chicago, was $4,844. It is 1165 feet deep and furnishes an abundant supply of fresh water for the extensive lakes in the Park.

The tops of the 100 fire plugs in Indianapolis which are to be abondonded have been painted white by the fire boys, und they have strict orders not to atdach to them at all.

We are informed that the new water works at Dixon, Ill., are to be built by a private company and that an ordinance has been passed by the city council, conferring the privilege.

Quite recently the Exeter Town Council (England) decided to postpone the purchase of gas works, "on account of the success of the electric light and the probability of its superseding gas."

The water commissioners of San Francisco offered $9,500,000 for the Spring Valley water works, but the company declined the price. They will now look to the Blue Lakes for the supply.

The people of Manchester, England, propose to obtain a supply of water from Thirlmere in the Lake district—90 miles away from the city. The ratepayers have sanctioned it. If this scheme is carried out there will be a call for a large quantity of pipe.

The Alton, Ill., water works company, are making a second extension of a half mile of mains for fire protection purposes. They have now over 10 miles of pipe and 91 double fire hydrants set, having commenced a year and a half ago, with 8¼ miles of pipe and 80 hydrants.

The Louisville, Ky., gas company, groaning under the continuous growling of people and press, has notified the Council Committee that it will reduce the price of gas to manufacturers from $1.43 to $1.18, and to private consumption from $2.70 to $2.38, if a guarantee will be given that the pipes of no other company will be allowed to be laid in Louisville.

A scheme is on foot for supplying London, Eng., with water by means of boring. It is proposed that the requisite number of wells shall be sunk at distances varying from fifteen to twenty miles from the centre of the metropolis. By this means it estimated that a supply of sixteen million gallons per day will be obtained at a total cost of £5.500,000. There are several important set-offs, however, which will reduce the annua charge to the ratepayers much below the amount represented by the interest of the capital sum required.

The Detroit (Mich.) *Post* says: "The Alpena Common Council has contracted with Walter P. Hanchett, of Rochester, N. Y., to supply the city with water. The city agrees to pay him $5,000 a year for 80 hydrants and gives him the exclusive right to lay down pipes and mains through the streets and alleys for the use of citizens for thirty years. The water is to be brought from the South Branch, above Wolf Creek, about nine miles distant, and 150 feet above the city, and the new water works are to be ready for use within a year after signing the contract."

Messrs. Cramp & Sons have now completed, with the exception of the boilers, the immense steam pumping engine which is intended for the Frankford water works, Philadelphia. The entire machinery will be ready to go into operation by October 1. This engine was built at the contract price of $36,000. and has a pumping capacity of 10,000,000 gallons per day. It is a double cylinder engine, the smaller cylinder being 40 inches and the other 60 inches in diameter. The pumps are 21 inches in diameter, and five feet stroke. The Frankford reservoir has a capacity of 36,000,000 gallons, to which have been run a 30 inch pumping main and 20 inch distributing main. There will be, three boilers, two of which will furnish steam for 500 horse power. The third boiler will be held in reserve for emergencies.

A tunnel in progress of construction in Baltimore, in connection with the water supply system of that city, is six and four fifths miles long—36,510 feet—and is being built underground, for over four fifths of the distance through hard gneiss and granite. The tunnel, which is a circle 12 feet in diameter, extends from the Gunpowder river, about eight miles from the city, to Lake Montebello—the distributing reservoir—about one mile and a half southwest of the city, and is designed to conduct the water from the river to the lake. From the lake a conduit, 4,120 feet long, known as the Clifton Tunnel, conducts the water to a point where it enters six mains, each 4 feet in diameter, which convey the water to the city, a distance of 1,900 feet. The country along the line of the works is hilly, and the tunnel varies in depth below the surface from 67 to 353 feet. There are fifteen shafts in the main tunnel, the deepest extending 294 feet below the surface. The fact that the water supply tunnel lies near enough to the surface to allow of numerous shafts greatly facilitates its construction. The work of the tunneling is all done by hand, it being cheaper than the machine work in a drift of such narrow diameter. This tunnel will be the longest in the country, and there will be only two larger in the world—the Mont Cenis, which is eight miles in length, and the St. Gothard, now in progress of construction, and which is to be nine and one quarter miles.

The new crib, of the Cleveland water works, in Lake Erie, which is progressing towards completion, will measure sixty-five feet in height from the water line to the light tower, and will be constructed of stone from three feet six inches below the water line to a height of thirty-two feet six inches. The first three courses are built of Marblehead lime stone, laid with Louisville

cement. The rest will be built of Ohio sandstone, from the Peninsula quarries. The outside stone work will be pointed up with Portland cement. The bottom course of stonework is five sided, each side being nine feet long and three feet six in height and width. The next course will be ten sided and the building will be finished in this form. There will be twelve courses of stone in all. The first, second, third, fourth, sixth, seventh and eighth will each be held together by a strong iron band set into the stone. From the top course to the eighth forty-five one and a quarter inch iron rods will be run to strengthen the upper portions. The stone work will be surmounted by an iron roof, the frame and all being constructed of iron, running up into a tower in which will be placed the light. The interior walls will be built of brick and the dwelling and all interior arrangements, will be perfect in point of comfort and convenience. A. A. Macdonell, of Chicago, is the contractor for the work.

MINING.

A correspondent at Vanceburg, Ky., 80 miles from Cincinnati, chronicles the discovery of a rich mine of zinc there.

The Montreal *Gazette* is confident that the Canada gold fields have "millions in them" if they could only be worked properly and persistently.

Parties who have gone over the ground say that the opening of the Cincinnati Southern road will open red oxide iron ore beds adjacent to the road.

Coal mining is becoming quite an important interest in Alabama. From a yield of 4,000 tons in 1873, the product of her mines grew to 65,000 tons in 1876.

The aggregate exports of petroleum oil this year are 121,000,000 against 84,000,000 gallons last year. Over a million gallons are daily exported from New York.

Extensive coal fields have been discovered in Stephens county, Texas. They are said to underlie pretty much the whole county, and the coal is of excellent quality.

130 tons of silver ore have just been transported from a mine in Utah to this city, for smelting purposes at the works on Jefferson stree', by way of experiment.

Coalville, Iowa, near Fort Dodge, has been so undermined by coal mining that the earth is gradually sinking all about the town. It is ruining the walls and hardly a house stands plumb.

The iron interest of Georgia promises to be one of leading importance. The economy with which the work of mining can be conducted, owing to the unusual favorable conditions obtaining, points to this State as the scene of large and successful operations.

Among the curiosities taken from a Nevada mine is a piece of sandstone with grass roots still clinging to it, and showing native silver ore all over its surface, petrified wood impregnated with ruby silver, and a mass of pure chloride of silver that will assay $3,000 to the ton

The coal areas of the world aggregate 270,200 square miles, of which the United States has 192,000; Great Britain, 11,900; Russia, 11,000, and Nova Scotia, 18,000. The production in 1874 was 274,262,000 tons, of which England took the lead with 125,070,000, while the United States mined 50,000,000; Germany, with only 1,800 square miles of coal area, 46,658,000; Russia produced only 1,292,000 tons, and Nova Scotia, 1,052,000. Belgium, with an area of only 900 square miles to draw from, produced 14,670 tons.

The *Engineering and Mining Journal* says: "The copper mines on the line of the Texas and Pacific R.R., in New Mexico and Arizona, are as important in extent as those of Chili or Peru. The ores are exceedingly rich, averaging $100 to $200 per ton. Mining is easy; immense quantities can be produced at about the cost of mining iron ore in Pennsylvania. In Chili and Peru there are 500,000 tons of copper mined annually. On Lake Superior there are some 400,000 tons mined annually. If 100,000 tons were mined annually on the line of this road, it would yield to the railroad $2,500,000, and this annually. There are immense deposits of lead and silver ore along the line. For instance, opposite Las Cruces, is a whole mountain of lead and silver ore which could be utilized as soon as railroad reaches there."

MISCELLANEOUS.

Davenport, Iowa, is adopting a sewerage system.

Halifax, Nova Scotia, will borrow $20,000 for sewer purposes.

A column of masonry in Kansas marks the geographical center of the United States.

It is said that pig-iron is made cheaper in Alabama than anywhere else in the country.

An experiment with a life saving apparatus in New York the other day, resulted in a life being lost.

The lake survey party who have been at work in Toledo Bay, have concluded their work. The Mississippi river will be the scene of their future labors.

The engineers of Marseilles have, it is said, discovered that since the opening of the Suez Canal the level of the Mediterranean has sunk some eight centimetres, or say 3¼ inches.

The Whitby, Ont., town council has appointed a committee to enquire into the most feasible plan of erecting a main sewer for the town, to cost in the neighborhood of from $8,000 to $10,000.

The Great Eastern, the enormous vessel that has thus far proved an unprofitable curiosity, is to be transformed into a huge floating refrigerator, and used in the conveyance of American meat to England.

The canals in this State are not profitable as the report of the Canal Commissioners show that the receipts for March, April and May were $23,682.83, while the disbursements for the same period were $28,841.

There are at present in France three Chinese officers who are engaged in studying at the Creusot works the latest discoveries and processes of metallurgy. From there they will go to England, in order to inspect the iron and engine works.

It is said that the expansion and contraction of the iron of which the dome of the Capitol at Washington is constructed are such that the dome sometimes moves during the hot weather as much as an inch and a half in twenty-four hours.

It is stated that the cost of the work on the Interocean Nicaragua canal will be $80,000,000, and that it can be completed within five years. No appropriation will be asked of Congress, but subscriptions will be opened in all parts of the world.

The canal around Mussel Shoals, in the Tennessee river, will be fourteen and a half miles long. Something less than a million of dollars, in addition to the amount already expended, will be necessary to complete the work. The locks will be large enough to accommodate a first class Mississippi river steamer.

There was recently quarried, without the use of powder, at the Barre granite quarries, in Vermont, a block weighing about six hundred and eighteen tons—being forty feet long, seventeen feet high, and ten feet thick. This immense stone is said to be perfect in every respect and is believed to be the largest block of granite every quarried in that State.

Linn County, Iowa, has appropriated $20,000 to build a boulevard from Cedar Rapids, to Marion the county seat; the contract has been let to O'Hanlan and O'Hara, at $19,500, and the work is progressing. The boulevard is to be sixty feet wide, with nothing like steep grade anywhere, and the contract has been let at very low figures. The distance is about six miles.

There are seventy establishments in the United States devoted to the production of window glass. Of the several States, New Jersey has the largest number, twenty-seven. The capital invested there is about $6,000,000, and the annual production between two and three million boxes of the various sizes and qualities of glass. At the present time it is believed that fully three-fourths of the factories are closed.

The ventilation of the Boston common council chamber is progressing rapidly. The system includes an air shaft leading from the basement to the chamber, through which 7500 cubic feet of pure air at a proper temperature will be forced by a blower in the basement, which will be worked by a five-horse power engine. It will be distributed over the rooms by means of grated openings under each seat.

Spanish engineers are reported to have arrived at Marseilles for the purchase of apparatus resembling that being used for the St. Gothard tunnel. It is proposed to bore a tunnel from near Algeeciras, in Spain, to a point between Algiers and Ceuta, a distance of nine miles. The cost is estimated at $20,000,000, and the promoters are said to have already raised a considerable sum.

The great Corliss engine in machinery hall, Philadelphia, has been taken down and packed ready for removal to Providence. It will take seventy cars to carry it.

It has been discovered that the wires of an electric apparatus used in Providence, R. I., for lighting street lamps can be utilized so that any policeman, wherever in the city he may be, can talk with an officer at headquarters by simply stepping to a lamp-post and attaching to the wire a small telephone which is carried in his pocket.

Bristol, R. I., dates back nearly two centuries, and long before the Revolutionary War her streets were laid out by a royal engineer, who did his work so well that no modern macadamizer has been able to improve on it. It is asserted that this is the only ancient town in America, with the exception of Philadelphia, where the streets are all made "on the square," and where, for the whole distance of each one, they run as straight as an arrow.

The deposit of soil at the mouth of the Suez Canal is exteading the coast into the Mediterranean Sea at the rate of fifty yards a year, and this is necessitating great expense in dredging. Many thousands of cubic yards of soil have been removed, but the trouble and cost have led the British Government to order a new survey on that portion of the coast, to ascertain the actual rate and cause of the rapid depositing of sand at the canal's mouth, and also to discover, if possible, some system of protection against the accumulation.

The work at the rip-raps on the Nebraska side of the Missouri river, opposite Council Bluffs, is being pushed forward with redoubled vigor for the reason that fresh trouble with the voracious current is feared. The sand continues to wash away at a lively rate, and the water is menacing the work which has already been done. At the present time a trench is being dug inland forty or fifty feet from the water front, which is to be filled with stones, and is expected to furnish an effectual barricade against the further encroachments of the current.

Philadelphia which was the first to practically adopt steam upon its horse railroads, has now furnished an improvement in horse car propulsion, the invention of Gen. Imboden, which promises greatly to simplify and influence the change from horse to steam. Gen. Imboden's engine which is very compact, simple and every way inoffensive, can be readily attached to the cars now in use, and thus commends itself on the score of economy. A test car has been made of the same size as that of an ordinary horse car, so as to demonstrate thoroughly that in order to convert the latter into a locomotive nothing is necessary but to take off the front wheels, put his handy little engine in their place, and nail up the front door. The interior and the rest of the car can be left intact. The new car occupies four feet less street space than one of the dummies now in use in Philadelphia, and ten feet less than a horse car, the horses being dispensed with.

"The English at all events," says a letter-writer, "know how to make roads. Their wood pavements are magnificent. London has set the fashion of wood, and Liverpool is beginning to follow it; but there are no pavements in the States to touch these wooden roads of England. They are laid on foundations which in some cases have been solidifying since the days of the Romans. On the foundations they lay macadam and cement several feet deep, and then come blocks of pine, laid with mosaic-like accuracy. There is a piece of wood pavement of this kind in Oxford street, London, which has not been repaired for over two years, and it looks as substantial and perfect as when it was first laid down. The average price of this kind of pavement is about $4 per square yard, and the companies keep it in order for two years without charge, and then guarantee it for fifteen years at an annual charge of twenty-five cents per square yard for maintenance, which enables the pavers to relay the road, if necessary, after eight or ten years."

THE BUSINESS OUTLOOK.

Engineers and contractors scan, as closely as any other classes, the reports of trade and commerce which they find in the papers, in order to see, if possible, symptoms of a revival of business and a strengthening of public confidence. Occupied as they are, almost exclusively, in planning and carrying forward works of public improvement, it is natural that they should be among those who have felt the present depression in business most severely; for such works are not inaugurated in a time of pecuniary distress. When the stream of commerce again swells and fills its former channels, we may confidently look for those good times in engineering which are the desire of all. Can we see any indications of the rising tide? The time of slack water has endured so long that we can reasonably expect the turn to be at hand.

A careful inspection of our exchanges, as well as information gleaned from other sources, has convinced us that a more confident tone is heard in business circles generally; and that not only is the prospect for a fall trade excellent, but the movement has already set in. We must not expect to see again the feverish excitement of the years since the war and preceding the panic of 1873, but we shall soon see plain indications of the return of a reasonable degree of prosperity. As the *Boston Advertiser* states it: "Wild and reckless speculation has given place to careful buying and selling, and, although the result may seem to be a great diminution in the amount of business doing, yet it is really a most important and beneficial change. Under the present conditions, business more nearly represents the actual capacity of the country for paying for that which is bought." "The practice of 'biting off more than they could chew,'—to use a well worn expression—has gone out of fashion with business men and in the business world, and the result will be seen in a more complete assimilation and better digestion, to the great advantage of the commercial health."

The great yield of breadstuffs throughout the West, and the foreign demand for them which now exists and must continue, will put money into the pockets of the farmers. The movement to the sea-board has already commenced, and is creating activity in commercial centres. The yield of cotton promises to be large, the wool trade is decidedly improving, and it is stated that the hog crop will exceed considerably that of former years. Some authorities look for an early and sure sign of improving business in the stiffening of both foreign and coastwise freight rates, and this indication is not lacking. The reports from New York, Philadelphia, Baltimore, St. Louis and New Orleans are very encouraging. The public, therefore, has every reason to think that a better business season is in store for us than we have seen for some time.

Starting as ENGINEERING NEWS did at a time of great depression, it has received a cordial support from the profession which, considering the times, could hardly have been expected. When many engineers have found it so difficult to obtain work, that they have been obliged to seek other means to gain a livelihood, when the sum charged for this paper has seemed of more importance by far than in years of better business, and when people have felt the need of reducing their expenses to the lowest point, the steady growth of our subscription list has clearly indicated that the NEWS is filling a needed place in the current literature of our profession and is indispensable. In our personal intercourse with engineers and contractors, and from the reports of our agents, we get the same story, one of hearty approval and good wishes for the future.

When our friends' pocketbooks begin again to swell, we hope to see a still more decided increase in the list of our supporters, and we can cheerfully promise to do more and better for them in the weeks to come. Our columns of contracts to be let and general intelligence, works contemplated and in progress, have, we find, been well appreciated by contractors and others, and we intend to make this department even more comprehensive than before. We have several plans for the future which only require the cordial support of our patrons to make them feasible, and to render these pages still more interesting and valuable. If those of our readers who feel interested in our success —and we are sure that all do—will make a little personal effort in our behalf, to urge its merits upon their friends, to send us new subscriptions, and to forward such items of news as may fall in their way, they will be repaid by the improvements which we shall be able to introduce. We wait for the reply.

DETROIT AND MILWAUKEE RAILROAD IMPROVEMENTS.

Quite recently we had the pleasure of examining some railway improvements which aptly illustrate the mission of the civil engineer as an organizer, and of the value to him of "readiness of resource." This qualification is, of all others, expected to be largely that of an engineer, and to him the public looks for the efficient carrying out of any constructive enterprise, with the help of such materials as may be at hand. In these days of bankrupt railways this faculty of making the most of existing resources is a valuable one, and we have no doubt that many excellent improvements have been most successfully carried out by engineers and managers of railways, simply because the necessities of their position obliged them to look about them and make use of such materials as were within reach of their means.

The Detroit and Milwaukee Railway running across the State of Michigan, from Grand Haven to Detroit, 189 miles distant, is one of the oldest roads in the country. From Grand Haven to Milwaukee it is 85 miles and to Chicago 110 miles, across Lake Michigan, on which two routes steamers make round trips daily. The river, which enters Lake Michigan at Grand Haven, is bounded on the north side by high hills of drifting sand, while to the south the country is a continuous slough. In the early history of the railway, its projectors conceived the idea of building a town on the north side of the river and consequently run the road across the river (which being quite tortuous necessitated several bridges) and located its western terminus at the foot of a hill where the drifting sand left no room for tracks, and which threatened even the buildings with pompeian destruction. A town was laid out on the sand dunes, but up to date no person has been seized with a desire to buy a lot on that side of the river, and wiser councils at last prevailing, it was determined to bring the road in on the south bank of the river and to the existing town.

But the only available ground was a broad and deep marsh to pile and fill which would be enormously expensive and quite beyond the means of the company. The chief engineer of the road, Mr. Geo. Masson, very quickly devised a method for overcoming the difficulty, which is at once effectual and economical.

Like all Michigan lake ports, Grand Haven is a town of saw mills, and so the materials were at hand, slabs and sand, and were to be had for the hauling. Mr. Masson built slab rafts upon which the ties were laid and the trains at once run. Sand was hauled on and the track was raised until the road-bed became permanently solid. In this way the slabs and edgings from the mills, and the sand from adjacent hills have been utilized until 13 acres of marsh have been filled up affording yard room for tracks, for 1 freight house 450 by 50, a passenger house 200 by 33; engine house 107 by 70, with seven stalls, a shed 310 by 45, a wharf 740 by 45 feet, and a wheat elevator (not owned by the company), the total cost of the improvements being about $200,000. These improvements are of the most substantial character, and convenient application, and are most creditable to the gentleman who designed them and successfully completed their construction.

The road for several years has been in the hands of a Receiver, the present incumbent of the office being C. C. Trowbridge Esq., and the revenues after paying running expenses are applied to the improvement of the property. After leaving Grand Haven the river and marsh are crossed by two iron swing bridges, built in 1869 by the Detroit Bridge and Iron Works: between Grand Haven and Grand Rapids, there are also 2 Pratt Truss Bridges of 100 feet span each, built in 1870, and 1 bridge with Plate Girders of 6 spans, each 47 feet, built in 1876, while at Grand Rapids the old wooden bridge is being replaced with Plate Girders on stone piers; five spans are 100 feet each and 2 spans are 60 feet each. On the 189 miles from Detroit to Grand Haven the east 146 miles have been laid since 1873 with steel rails, the balance is laid with the original Welsh iron rails, which are still in excellent condition and owe their preservation largely to the liberal use of ties which the engineer has laid at unusually frequent intervals. In fastening the fish plates, Mr. Masson has adopted a tapering key driven into a slot in the outside end of the bolt, instead of using a nut and screw and he considers his method a great improvement.

At six miles east of Grand Rapids and on the summit of a grade, is the Saddle Bag Swamp, a deep sink hole of 2,600 feet in length, 50 feet deep in the center, and 60 feet to clay. The contents of this hole are water and muck, and the thin crust which covered the mass was incapable of carrying but a very light weight. A former engineer had attempted to build a roadway over this hole, but after he had dumped a good deal of material into it with little prospect of succeeding, the attempt was abandoned and for twenty years the roadway has been maintained on seven and eight degree curves around the northern top of the slough. This season Mr. Masson attacked the problem with his slabs and sand, and in three months with one train, 50 men on the train and 25 on the dumps, raising track, etc., and at a cost of $10,000 in all, a solid roadway was carried over the hitherto unpassable ditch and all trains are now running across it. Slabs and edgings 16 feet long were laid down and firmly bound together by being crossed, until a raft 10 feet thick was built upon which the train of sand cars could be run. Sand was hauled on until the sinking of the road-bed ceased and the track was brought to grade. The greatest difficulty to contend with, was the tipping of the rafts which were a source of great annoyance, and had to be carefully guarded against. The roadway is now suspended over the hole by this raft, and no fears are entertained as to its permanence, since there is no outlet for the water and no chance for a washout. If the water could be drawn off by means of a drain, which, however, would need to be nearly 50 feet under ground, the road-bed would be made still more permanent. In the saving of wear and tear of rolling stock and rails in the sharp curves, the cost of the improvement will soon be made up.

There are no stone quarries on the line of the railroad and to replace wooden culverts with stone ones was expensive. But among the old iron rails taken up were many that would bring only the price of old iron; these the engineer used as coverings to his culverts. On 4 ft. culverts with stone walls rails were laid, web down, and just far enough apart to allow tracks to be laid so as to fill the space; a most excellent and permanent covering was thus formed and with materials for which no cash had to be expended. Over 4 feet openings every fourth girder was made by setting one rail upon another, web to web; but the method is specially adapted to 4 feet openings.

The Detroit and Milwaukee Railroad is now under the superintendence of S. R. Callaway, who, although young in years, has proved himself a most efficient railway manager. The road traverses a region of country that is being rapidly developed and improved, and it is to the local traffic along its route and its feeders from the north, that the road will always have to look for its revenue, as Lake Michigan is a barrier which places competition with more Southern routes out of the question.

OUR RAILROADS AND THEIR ECONOMICAL USE.

V.

The want of a thorough and comprehensive understanding of the benefits conferred by our railways, and a knowledge of the great stores of wealth they have rendered possible to this country, is one great reason why so much opposition has been made by those who were deriving the most benefit from them. As a people we have not fully considered, much less appreciated their value, in *producing* wealth, as one of the greatest economical uses they possess, is by rendering that valuable which without them would be almost totally valueless in its own natural locality. Take for instance the fine Ohio building stone, which is so largely used in Chicago, Boston, New York, Philadelphia and many other cities; without railways, this stone would hardly possess even a small local value, but in consequence of

them it is a source of great wealth. We do not find all the valuable mineral deposits in one section of the country, but widely separated; excepting the precious metals, the others are so bulky in proportion to their value, that it is only by cheap transportation, that they become a source of wealth. Take coal, an article as indispensable to the country at the present time as bread; an article which not only supplies heat to prepare our food, warm our houses, but is also the great factor to develope the power necessary for transportation, and by its use manufactures can be carried on at any point, while before the steam age, water power dictated location. Yet notwithstanding its absolute necessity, it is largely dependent on cheap transportation for its value.

What we have said about the value of mineral products depending so much upon cheap transportation, is equally true of the majority of agricultural products. The luxuriant crops of the western prairies were sometimes left on the ground to decay for want of rapid and cheap means of conveying them to market. The utility of an article often depends upon its place of production, the use for it in some other locality. To show how the value of articles is affected by the means of transportation, we have prepared the following tables: giving the cost by the usual means. It has only been the cheapness of the last two that has rendered available the great wealth of our country.

TABLE No. 1—BY COMMON ROADS AT 15 CTS. PER TON PER MILE.

	Market value per ton.	Miles from Market.									
		10	20	30	40	50	60	70	80	90	100
Coal	$4 00	$2.50	$1.00	$	$	$	$	$	$	$	$
Iron ore	7 00	5.50	4.00	2.50	1.00						
Potatoes	9 00	7.50	6.00	4.50	3.00	1.50					
Hay	15 00	13.50	12.00	10.50	9.00	7.50	6.00	4.50	3.00	1.50	
Corn	16 00	14.50	13.00	11.50	10.00	8.50	7.00	5.50	4.00	2.50	1.00
Oats	20 00	18.50	17.00	15.50	14.00	12.50	11.00	9.50	8.00	6.50	5.00
Pig iron	30 00	28.50	27.00	25.50	24.00	22.50	21.00	19.50	18.00	16.50	15.00
Wheat	40 00	38.50	37.00	35.50	34.00	32.50	31.00	29.50	28.00	26.50	25.00

TABLE No. 2—BY RAILROADS AT 3 CTS. PER TON PER MILE.

	Market value per ton	Miles from Market.									
		50	100	150	200	250	300	350	400	450	500
Coal	$4 00	$2.50	$1.00	$	$	$	$	$	$	$	$
Iron ore	7.00	5.50	4.00	2.50	1.00						
Potatoes	9.00	7.50	6.00	4.50	3.00	1.50					
Hay	15.00	13.50	12.00	10.50	9.00	7.50	6.00	4.50	3.00	1.50	
Corn	16.00	14.50	13.00	11.50	10.00	8.50	7.00	5.50	4.00	2.50	1.00
Oats	20.00	18.50	17.00	15.50	14.00	12.50	11.00	9.50	8.00	6.50	5.00
Pig iron	30.00	28.50	27.00	25.50	24 00	22.50	21.00	19.50	18.00	16.50	15.00
Wheat	40.00	38.40	37.00	35.50	34.00	32.50	31.00	29.50	28.00	26.50	25.00

TABLE No. 3—BY RAIL OR NAVIGATION AT 1 CENT PER TON PER MILE.

	Market value per ton.	Miles from Market.									
		150	300	450	600	750	900	1050	1200	1350	1500
Coal	$4.00	$2.50	$1.00	$	$	$	$	$	$	$	$
Iron ore	7.00	5.50	4.00	2.50	1.00						
Potatoes	9.00	7.50	6.00	4.50	3.00	1.50					
Hay	15.00	13.50	12.00	10.50	9.00	7.50	6.00	4.50	3.00	1.50	
Corn	16 00	14.50	13.00	11.50	10.00	8.50	7.00	5.50	4.00	2.50	1.00
Oats	20 00	18 50	17.00	15.50	14.00	12.50	11.00	9.50	8.00	6.50	5.00
Pig iron	30 00	28.50	27.00	25.50	24.00	22.50	21.00	19.50	18.00	16.50	15.00
Wheat	40.00	38.50	37.00	35.50	34.00	32.50	31.00	29.50	28.00	26.50	25.00

From an examination of the table we see that the distance of a commodity from market, affects its value somewhat in proportion to the cost of transportation. Take coal at $4 per ton; by common road its transportation costs 15 cts. per mile. If it costs one dollar to mine and prepare it for market, including interest on investment, and cost of loading and hauling, it could only be taken 20 miles before the cost of production and hauling would equal the price received. The proprietor of the mine hiring all the labor, would lose money by haul ng over the 20 miles; on a less distance he would make a profit. If he is over that distance from market, it is evident, that in order to carry on his mines, he must reduce the price of production and hauling, which would have to be borne by his employés. By railroad at 3 cts per ton per mile, he could send his coal any distance less than 100 miles, before the cost of production, and the cost of transporting would equal the market price, while at 1 cent per mile it would be anything less than 300 miles; of other articles we see the same principles affecting the values. It is noticeable that the price paid for an article by its consumer consists of two elements, 1st: The price paid for the article to its producer at the place of its production. and: The cost of transportation to the consumer. In the last element are included many commercial expenses which also enhance the cost of the article to the consumer besides that of transport proper such as insurance, interest, commission, dockage, storage, packing, transhipment, and a great variety of commercial details, depending somewhat upon the kind of article, which in the aggregate forms a large portion of the cost to the consumer oftentimes forming one-half to three-fourths of the selling price.

The products of agricultural labor are for the most part quite bulky in proportion to their value, while others are of such a nature that they will deteriorate in a short time by natural causes, where they are grown. Now in order to render such productions of the greatest value to both the producer and consumer, transportation must be *cheap*, *speedy* and *safe*. Both derive benefits which otherwise would be impossible. The cities are daily supplied with articles fresh and of the best quality, while the producers receive a better price than would be possible if transportation were slow and consequently expensive.

Every advance in the means of transportation, reducing its cost and augmenting its speed, tends to the reduction in the cost of articles, to increased consumption, and consequently an increased production to supply the demands. Farming lands by being brought nearer to market, have their value enhanced, and the railways thus render that which was almost valueless of importance, and in so far increase the natural wealth and prosperity of the community. What has been the result of the rapid improvement of communication? It has rendered valuable the great mineral resources of the country, it has opened to an increased population the fertile prairies of the West and Northwest, increasing the value in more than a tenfold ratio. The rise of land largely due to the increased facilities of commerce by railways has been the greatest factor. Natural water facilities for inland commerce only accommodate a small portion of our territory and in the northern part of the country is only available for a period of 5 to 7 months in the year, their courses are not in direct lines to the markets of the country, but follow their circuitous meanderings and rapidly perishable products cannot be sent long distances on them. By water communication alone, commercial intercourse would be confinedto a limited territory. The wide distribution of mineral resources, the topographical features and climate of our country, are so varied that in order to realize the most of our vast and illimitable natural wealth, there follows of necessity a great diversity of occupations in order to economize time, capital, and labor.

The productions of each section of the country are obtainable in abundance vastly more than the particular section needs, and other sections are similarly situated with their own productions; while it might be possible to all to live, yet there could only be a very limited prosperity, but interchange these commodities one with another and natural wealth and prosperity begins. The products of hands and brains find a market, and there is a reciprocal advantage to all parties concerned. These are the benefits conferred upon a country by a system of railway communication. Only the most sagacious and far seeing of our citizens, foresaw these great advantages. The older states before the era of railroads expended large sums in constructing canals, assuming large debts, but only in a few instances have the canals yielded a revenue commensurate with their great cost, the property of the states being actually taxed not only to build but to operate them. Yet indirectly they were of far greater benefit to the communities than their cost, by the rapid enhancement of property, as they rendered possible the interchange of commodities between markets. Many of them have now been abandoned, yet no one considers them a poor investment and upon the whole they subserved their purpose at the time, and now only give way to the railroads, a more sure and rapid means of transportation.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

VI.

Among the most valuable of the field notes of a Dominion land surveyor are the Bearings of Township Lines. These are supposed to be taken with particular care, and their possession saves frequent astronomical observations, and a great deal of unpleasant labor. The following are the bearings of the lines in the township of Elizabethtown, county of Legds, taken by Norman Booth, P. L. S, now deceased:

Concession.	Bearing.	Concession.	Bearing.
1	N 30° 12′ 30″ W	7	N 29° 44′ W
2	30° 58′	8	30° 26′
3	31° 54′	9	29° 29′
4	31° 18′	10	29° 22′
5	28° 58′	11	28° 21′
6	29° 13′		

Width of concession road 40 feet, side-roads every six lots, and 40 feet wide; Concession roads on north side of line except west half of road between concession 9 and 10; the east half is on north side, and the west half on south side. In two adjoining townships the road allowances are 66 feet; in one it is on north side of line, and in the other on south side. The first range of townships in this county front south, and the second range front north. Depth of concession in first range 105.27 chains; width of lots 19.00 chains.

These notes show the absence of uniformity in the townships and the corresponding care that is necessary in making surveys of lot lines.

The use of the foregoing notes is apparent when it is understood that the lot lines in each concession must be run parallel to the township line at that end of the concession from which the lots are numbered. There are eleven concessions in the township just named, and in each concession perhaps twenty lots, every four of which make a mile frontage. To survey the line between lots 16 and 17, the surveyor, having the bearing of the township line, sets up his theodolite over the corner, which has been previously determined, and when the pole star is early at either its eastern or western elongation, he sets the vertical cross hair on it and follows it with the tangest screw until it remains on the wire for a short time, when he at once sets a stake some hundreds of feet distant, by means of an assistant and a candle held in front of the stake so as to throw the light on it, another assistant in the meantime holding a light so as to illuminate the wires of the instrument. Many transit

theodolites have a hollow axis, into which the light is thrown from a small lamp supported by a stand which slides into a groove on the right-hand standard, thus dispensing with the services of an assistant, but we found in practice that the assistant and a lantern were preferable. Taking an observation on a night when it is calm and comfortable and the sky cloudless is rather pleasant than otherwise, and is often a blessed relief to the surveyor, who is thus allowed to get out for awhile from the usually stifling sleeping-rooms of the average farm-house, into the pure air. But to turn out on a windy wintry night, with the mercury from 10° to 20° below zero, two feet of snow on the ground, and the corner post some distance off, following a slow moving star, with one's eye-lashes nearly frozen together, and fingers benumbed, watching one shivering assistant lest he kick a tripod leg and hallooing to another several hundred feet away in the dark, and who persists in going in the wrong direction, or lets the light be blown out, or wanders about generally, to no purpose, until one's patience is exhausted, throat sore, and stock of expletives given out, before the stake is properly set and a line secured for the next day, is quite another thing, and to be appreciated must be tried. It sometimes happens also that the night is cloudy and stars invisible; there is no alternative but to wait for clear weather, even if it takes days, without one is near enough to the town line to make it advisable to run a base line along the concession. If one does not have in his note book reliable bearings of the town lines, two observations are necessary, which, if the surveyor is enough of an astronomer to obtain the true pole at different hours, may be taken the same night. In the morning the bearing of the boundary line, to or from which has been added or subtracted the angle of variation from true north, of the line taken the night before (and which is given for every day in the year in the Canadian Almanac), is turned off and the line run to the middle or rear of the concession according as it is single or double fronted. The foregoing is the method of making a farm survey from which there is scarcely ever any deviation.

Surveys are charged for by the line and vary greatly; the surveyor takes his chances on obtaining observations, and the possession of his bearings of town lines inures to his advantage, as he always bases his price on two observations, while it may frequently happen that he has run lines in the vicinity, and will so make his survey without any astronomical observations being taken.

Surveying for farmers is always disagreeable. As a class they live most miserably, and the snow, rain, mud, brambles, mosquitoes, and fatigue is much more endurable to the surveyor than the villainous food, miserable sleeping arangements, and poisonous atmorphere that awaits him out of working hours. We have seen but little difference between the populous and cultivated districts along the St. Lawrence River and in the backwoods settlements; it was generally in one-roomed log houses, stifling with dirt and overrun with vermin, that the majority of the country surveyor's patrons were to be found; the better class of farmers either hold their boundaries by former surveys or by right of long possession, and consequently it is from the poorer men, or from the litigious ones that the income of the surveyor is derived. These people live like pigs; oftentimes with the pigs; men women and children occupy the same room; they keep this at furnace heat usually, and at night closely shut up lest the night air should injure their eyes; there are always children, and when they haven't got the whooping-cough, they have the measles, or sore eyes, or itch, or some other vile disease that helps to cultivate a love for domestic and rural life in the heart of every ambitious surveyor or his aspiring apprentice; we forbear to say anything about the average food, but it keeps one in a state of chronic sea-sickness; the light by which one may read or transcribe his field-notes, or figure up areas, is very frequently but a cotton rag tied to a copper coin and immersed in melted grease, while to help it all the ever-present plug tobacco keeps sending out its rank fumes. We consider the Canadian peasant not much more civilized than the Russian peasant, or than the foreign born peasant of the United States.

We believe the foregoing statements of the average experience of a country land surveyor in the Dominion cannot be refuted, and we feel that we are safe in saying that $1,000 is more than the average income of surveyors throughout the Dominion. Is the privilege of being a P. L. S. sufficient compensation for the money and time and labor spent in obtaining it, with the prospect of spending one's best years in the hardest kind of drudgery, in an employment requiring but a low grade of intellect, and necessitating constant association with an ignorant class of community?

The long year of apprenticeship finally came to an end. I had passed the college examination in the theory and mathematics of surveying, and I had now seen a fair variety of field pratice; I had purchased one of the most improved transit theodolites of Troughton and Sims, London, England, and was otherwise what might be considered ready for business on my own account. By reason of various delays, I did not put in an appearance at Toronto until the January meeting of the Board of Examiners. Judge of my surprise, disappointment and chagrin when I was referred to Sec. 17 of the Act, and informed that I would have to serve eight more months as an apprentice before I could be admitted for examination. The college terms were eight months each, there was a vacation of four months between the terms, making in all twenty months; a class-mate had gone up the year previous after twelve months of actual practice and had received his diploma; I considered that I was justified in expecting the same result in my own case, if I could actually pass the required examination. The wise men at Toronto did not see it in that light and there was no alternative but to return and serve out the balance of the remaining eight months necessary to complete thirty-six full months. Very naturally I prayed fervently for the welfare of that Board, both in this world and in the world to come.

I had given my time and labor gratuitously for twelve actual months, and had paid my own expenses besides. I had now to put in another instalment of eight months, and all for the purpose of learning how to run a farm boundary or a limit line; possibly to survey a township. By March I was indentured to a surveyor in one of the largest and handsomest towns on Lake Ontario; my master was a very able engineer and surveyor and my eight months servitude with him was a most delightful holiday, saving the single fact, that I was earning no money and had my living expenses to pay out of my own pocket. Business *had been* good, and the first two months were spent in copying the notes of a township survey just completed, platting them, and preparing them for return to the Land Office at Ottawa. We made a few farm surveys, did some engineering work and made occasional drawings, but the most of six months was spent in reading, and in otherwise making the most of the time, which on account of the many very agreeable people with whom I became acquainted, passed rapidly away, and I was ready by the following January for another interview with the wise men at Toronto. The wise men and the interview and also a list of the land surveyors of Ontario, we reserve for our closing chapter.

Written for "Engineering News."

THE METRIC DISCUSSION.

II. DECIMALIZING BRITISH MEASURES.

The arguments in favor of introducing the metric system are sometimes met by a proposition to reform our present weights and measures, instead of casting them all aside. Perhaps the best presentation of this plan yet published is at the close of an interesting lecture by the late Sir J. F. W. Herschel, the eminent astronomer, on "The Yard, the Pendulum, and the Metre." *

The lecturer is chiefly occupied with the subject of a natural basis for a standard of weights and measures. Referring with admiration to the degree of accuracy attained in the meridian survey upon which the metric system was based, he says: "Adopted as it is over a large portion of Europe; were the question an open one what standard, a new nation, unprovided with one, unfettered by usages of any sort, and in the absence of any knowledge of the existence of the British yard, should select; there could be no hesitation as to its adoption" etc.; but he is confronted with "the fact that England is beyond all question the nation whose commercial relations, both internal and external, are the greatest in the world, and that the British system of measures is received and used, not only throughout the whole British empire (for the Indian 'Hath,' or revenue standard, is defined by law to be 18 British imperial inches), but throughout the whole North American continent, and (so far as the measure of length, is concerned) also throughout the Russian empire; the standard unit of which the Sagene, is declared by an imperial ukase to contain *exactly* seven British imperial feet, and the Archine and Vershock precise fractions of the Sagene. Taking commerce, population, and area of soil then into account, there would seem to be far better reason for our continental neighbors to conform to *our* lineal unit could it advance to the same, or a better *a priori* claim, than for the move to come from our side."

This lecture is dated in the fall of 1863. The outlook at the present time is different. Since then the metric system has been introduced in Germany, Austria, Roumania and one or more South American countries. It has been adopted by laws which will take final effect hereafter in Sweden, and (according to the 9th report of the Warden of the Standards, British Parliamentary documents, 1875), in Norway. One of the latest reference books on this subject * states that in 1870 the use of the metric system was made obligatory by law in Turkey; but probably the effect on commercial transactions is not yet very great. It is worth noticing, by the way, that the countries here named constitute the entire European frontier of Russia.

Please observe too, that Sweden already had a complete decimal system, adopted in 1858, starting from her foot and pound. The metric system has been legalized in the United States (1866) and Great Britain (1864).

"An Act 'to provide for the ultimate adoption of an uniform system of weights and measures of capacity throughout British India,' was passed in October 1871. The *ser* is adopted under the Act as the primary standard or unit of weight, and is a weight of metal, in the possession of the Government, equal when weighed in a vacuum to one kilogramme. The unit of capacity is the volume of one *ser* of water at its maximum density, equivalent to the liter. Other weights and measures are to be multiples or submultiples of the *ser* and of the volume of 1 *ser* of water." This is taken from page 180 of "Rules, Tables and Data" the new publication 1877, by the well-known English engineer, D. K. Clark. As for Russia, Consul-General Bodisco is quoted as stating that "the Imperial Commission sent to Paris to inquire, reported in favor of the introduction of the metric system into Russia, and the government has the subject now under advisement." The only common point between the Russian weights and measures and those of any other country, is the connection above pointed out with the British foot, which was introduced by Peter the Great after his experience in English dockyards. Sixteen vershocks make 1 archine, 3 archines make 1 sagene. So the vershock equals 7-48 feet, or 1¾ British inches, the archine, 2⅓ feet, or 28 inches; the sagene 7 feet. This amounts to about as much in the way of a simple relation as the connection of our so-called "surveyor's measure" with long measure. Suppose that Gunter's chain had never been used in England, and that the Russians instead of their sagenes and vershocks had a chain equal to 4 British rods and divided into 100 links each equal to 7 92-100 British inches, how far would that go toward inducing them to adopt the whole British metrology, now that the rest of Europe is irrevocably committed to the metric system?

Sir John Herschel's exhaustive discussion leads him to the conclusion that the earth's polar axis is the best natural basis for a system of weights and measures. He proposes to make minute changes, which for commercial purposes are inconsiderable, in the foot, the ounce avoirdupois, and the imperial half-pint, so that the foot shall bear a simple ratio to the earth's axis, and that the half-pint shall be 1-100 of a cubic foot, and shall hold ten ounces of water. This scheme is not so well adapted for the United States as for England; because neither our dry pint nor our liquid pint has any

* Familiar Lectures on Scientific Subjects, Alex. Strahar; London and New York, 1866. The lecture here cited has been reprinted in "The Metric System," etc., By Charles Davies. A. S. Barnes & Co., New York and Chicago, 1871.

* Memoires Poids Mesures et usages commerciaux de tous les etats du monde. Paris: Hachette & Cie also Havre: A. Lemale, Aine. 1875.

thing to do with the British Imperial measure. All the capacity measures in the United States would have to be altered, in order to adopt it.

Upon this admirable basis it may be proposed to remodel our medley of weights and measures, and make a system either wholly or partly decimal. If partly, then by so much as we fail of being completely decimal by that amount we lose the benefits of, an entirely decimal system like the metric. Sir John Herschel evidently does not attach superlative importance to decimal subdivision. Besides dividing the foot into ten parts and making the cube of one-tenth hold an ounce of water, he would also retain the present division into twelve parts, and the earth's polar diameter would be expressed as 500,000,000 inches, (and could not be precisely expressed in feet and tenths). This two-fold subdivision of the standard unit, though it is sometimes spoken of as if it were an additional convenience, is really the source of endless annoyance. The reader who has ever tried to work in tenths from an architect's plan figured in inches, or has labored to instill into the mind of a stupid earthwork contractor what "Cut 1. 9" means on a grade stake, can appreciate the disadvantage referred to. There is increased liability to error in reading figures on plans, if two incongruous methods of subdividing are used indifferently.

If on the other hand the remodeling should be purely decimal, there would be nothing left of the existing units in this country except the foot and the avoirdupois ounce. If we are going to the extent of throwing aside everything else, might we not as well drop them too and take up the metric system. A minor consideration is worth mentioning which relates to the practical conduct of the change. When the metric units are used, the English will naturally be adopted; there will be no tendency for the foot to cling to the metre. But to abolish the yard while the foot is retained, to use the ounce constantly and abandon the pound, would be completely accomplished only after the lapse of a long time. The main question is; If we are bound to have a radical reform in metrology, at all events, shall we go far enough to bring ourselves into harmony with the rest of Christendom, and so oblige Great Britain to follow suit, or shall we preserve two or three of our multifarious units in the hope of maintaining a few years longer our uniformity with Great Britain's insular system, and with the possibility that Russia may adhere to the British foot?

England adopted the Gregorian calendar in 1752, which the Catholic countries of Europe had generally adopted about 1582. Russia has not adopted it yet, so that what we call the 15th of September is in Russia the 3rd of September. The old Roman figures (now happily supplanted by the Arabic decimal notation) "lingered longer in England than in any other part of the European world, having found an asylum in the dark and dull regions of Exchequer." So says Sir John Bowring on page 26, of his Decimal System" (1854). In a subsequent chapter giving a history of the practice of the Exchequer, he says: "A tally was a stick, (generally of hazel) prepared by an officer called the Tally Cutter, or Cutter of the Tallies; on the tally notches were cut, indicating the sum in the Teller's Bill, a large notch for M (or £ 1,000), a smaller notch for C (or £ 100), a smaller still for X (or £ 10), and so on for pounds, shillings and pence;" (page 118), and on page 124–5. "It is, indeed, scarcely credible, that the perplexing and entangled manner of keeping accounts by the Roman numerals, in the same barbarous style which was practiced before the Norman Conquest, was maintained at the Exchequer almost down to the present day; and the introduction of the English language and the Arabic numerals was successfully resisted by no less a personage than Lord Granville, on the ground, that if the barbarous usages of our ancestors were reformed, it would be difficult to understand the accounts, and the records of departed time." * * * * *Tallies* continued to be used down to the year 1782. It was only in the year 1831 that the Committee on Public Accounts, of which I was the Secretary, recommended the utter and immediate abolition of the ancient system, and the adoption of the Arabic numerals and the English language. It was in consequence of this change that, in the year 1834, the tallies were ordered to be burnt, a conflagration which led to the destruction of both Houses of Parliament—the Exchequer, in which the tallies were kept having formed a part of the ancient edifice of St. Stephen's."

Must the United States travel in such ultra conservative company?

ORIGIN OF THE METRIC SYSTEM.

Translated from the French of A. S. SARDOU by F. A. SNOW.

Before the commencement of the present century each province of France, and even each city, had its own particular system of weights and measures. Such a state of things, as each one thought his system the best, frequently occasioned error and fraud. They had tried several times but in vain to establish in France a uniformity of weights and measures; and in March, 1791, by the invitation of the government, a commission of scientific men occupied themselves to institute a fundamental unit of weights and measures, by whom it was decided that the new system should be based upon the dimensions of the terrestial globe.

Celebrated mathematicians had already measured these dimensions in different countries. In 1799 two celebrated astronomers, Méchain and Delambre, were requested to verify the operations previously executed and to continue them; they terminated the measure of the arc of the meridian at Paris comprised between Dunkirk and Barcelona. MM. Brot and Arago calculated the prolongation of this meridian as far as the island of Formentera one of the Balearic group. These extensive operations made known the distance in *toises* from the pole to the equator, and consequently the length of a quarter of a meridian. They found it to be qual to 5,130,740 ancient toises.

They divided this length by the number 10,000,000; the length obtained by the quotient was chosen as the fundamental unit of the new system. They gave it the name of metre, a word which signifies measure.

Thus the metre is the ten millionth part of a quarter of a meridian comprised between the pole and the equator, or the forty millionth part of an entire meridian.

All the other measures, weights and monies were derived from the metre.

The *Litre* is the decimetre cube; in commercial usage it has not, it is true the form of a cube, being instead that of a cylinder, but its capacity is the same as that of a cubic litre.

The *Gramme* is the weight in a vacuum of a centimetre cube of distilled water, at the temperature of four degrees above freezing.

The *Franc* is made from five grammes of silver, nine-tenths pure, mixed with an alloy of one-tenth copper.

The unit of square measure is the *metre carre.*

The unit of volume is the *metre cube.*

As is seen the relation of the different measures with the fundamental unit is so simple, that it will always be easy to replace the standard disposed in the archives if it should happen to be lost, and if time should alter the value of commercial measures. And the terrestrial meridian whose length has furnished the metre can be measured in all countries.

Thus having a fixed base, not in one particular locality, but, upon the globe itself, and belonging to all nations; simplicity in the relations of the units of each measure to the fundamental unit; uniformity in the dimensions of each principal unit; conforming to the system of numeration adopted by all civilized people, and extremely easy in all its calculations; such are the advantages presented by the metric system, advantages not offered by a single other system of weights and measures, and which can be unacknowledged only by ignorance and bad faith.

THE RIVER THAMES.*

BY JOHN BALDRY REDMAN, M. INST. C. E.

(*continued from page 244.*)

EARLY TIDAL CONDITION.

Five Centuries back the time of high water at London Bridge was reckoned three hours after the moon's transit; now it is two hours after, having been accelerated one hour. In the year 1700 the flood tide commenced three hours fifty minutes before high water; it is now five hours and a quarter, nearly one hour and a half earlier. In 1830 high water at London Bridge was one hour and three quarters after Sheerness, now it is one hour and a quarter, a gain of thirty minutes in forty-six years, due mainly to the removal of old London Bridge, the sectional area of whose water-way was 7,300 superficial feet, as compared with 17,600 feet, the area with the present structure. The old bridge, due to its massive piers and projecting "starlings," acted as a partial weir. The spring tides rose 6 inches higher on the lower than on the upper side, resulting in a step down of the high-water level from time not being allowed for it to attain the same altitude above as below the bridge; and at low water there was a step downwards, and a greater hindrance to the ebb due to the "starlings" formed of a nest of piles projecting beyond the piers, and a fall of from 3 to 5 feet of water was the result.

PRESENT TIDAL CONDITION.

By the removal of the old bridges, and by the substitution of modern structures with ample spans, the tide now flows higher by twelve inches above bridge than in former years, and ebbs about 4 feet lower above bridge, adding in effect about 25 per cent. to the tidal volume of water passing up and down twice in the day, and producing a rapid lowering of the bed, and greater exposure of the mud foreshores, the worst of which have been reclaimed and covered by the Thames Embankments. The low water has been lowered all the way from London Bridge to Teddington, viz., 4 feet at London Bridge, 3 feet 6 inches at Westminster, 2 feet 6 inches at Battersea, and about 2 feet at Teddington. The level of high water below bridge is much the same as formerly, but the increase in altitude is equal to 1 foot at Battersea, which, added to the depression at low water there, gives an increased range of 3 feet 6 inches. The ebb current has also been increased, and the water ebbing downwards over Teddington weir now passes through a smaller channel. The result is a lowering of the bed. The tidal water between London Bridge and Teddington having been thus increased by about one-fourth part, and added to that below bridge, has produced a corresponding progressive improvement of the port of London, aided by systematic dredging of shoals. This is further required between London Bridge and Teddington; also in places below bridge.

The velocity of the first of the flood above bridge is from 1¼ mile to 2 miles per hour, and of the last of the ebb from 2¼ to 3⅓ miles per hour. At the mouth of the Thames, south of the Maplin Sands, the greatest rate of springs is 2½ knots per hour, at the Kentish Knock 2.8, and at the Sunk 3 knots per hour; the two last being off the mouth of the river.

The interest attached to the well-being of the river, the great artery of British Commerce, has been evinced by numerous plans discussed during the last half-century; works that will regulate the breadth, increase the scour and depth, promote an increased range and duration of tide, are assisting nature's great agent, which, in its ever-recurring regularity of action, may be regarded as an emblem of the infinite, and has, in its ceaseless pulsations, well given rise to the old adage "Time and tide wait for no man."

Pliny's comparison of the progress of a river to the life of man is well known and oft quoted, and Denham's lines on the Thames contain a similar thought. It has been noticed as a characteristic of the river that, at the original formation of shires and sub-division of land, it was a noted stream, and that from Cricklade to Sheerness it is the natural boundary of counties.

Rennie's Report of 1834 referred to its insignificance as compared with its diffusion of wealth, power, and activity over the whole earth, making it incomparable to all other rivers combined; to its drainage area of 5,162 square miles; its length, with windings, 201½ miles, about double the direct length; its reception of twenty tributaries—fifteen of the principal are given in the Fisheries Commissioners' map—whose united length amounts to 464 miles; the fall in its navigable length from Lechlade to London of 258 feet, or about 21 inches per mile; its mean velocity 2 miles per hour, and the quantity of water flowing over Teddington weir at that time as 1,337 cubic feet per second.

LONDON WATER SUPPLY.

A volume of 1,337 cubic feet per second would be equal to 3,223,125 tons of water daily. The present

*A Paper read before the Institution of Civil Engineers, London.

daily quantity supplied to the London water companies appears from Major Bolton's last report to be 121,622,500 gallons, or 512,958 tons, so that nearly one-sixth of the total quantity of land water is abstracted for the London water supply.

This is equal to 198,179,670 tons of water as the annual want of London; now, however, sometimes estimated to include all demands at 250,000,000 tons.

The annual outflow of the Thames is 1,176,440,625 tons, which is equivalent to 3½ inches of rainfall over the drainage area of 5,162 square miles. Taking the annual rainfall at 24 inches, the London basin would yield 8,030,597,142 tons of water. Taking one-fourth of this amount, after allowing for evaporation, etc., 2,007,649,285 tons of water are available. This estimate is, however, about one and two-thirds the actual result, or in other words, instead of a depth of 6 inches of annual rainfall being available, not much more than one-half, or 3½ inches, is so, and this is only four times the quantity now required for the metropolitan water supply.

The average outflow is equal to from one-sixth to one-seventh of the annual rainfall.

The Royal Commissioners of 1869 estimated the amount at double, and that estimate appears excessive, the loss of evaporation, absorption, etc., according to Mr. Greaves, M. Inst. C. E., amounting to 20½ inches out of the 24 inches annual rainfall. The Water Supply Commissioners of 1869 only dealt with the drainage of the Thames valley above Kingston, amounting to 2,676 square miles, or less than three-fourths of the entire area. They estimated the average annual rainfall at 27¼ inches, and that one-third flowed down at Hampton.

The total quantity would amount to 6,493,227,321 tons; one-third of this amount is equal to 2,164,409,107 tons. This again is nearly double the actual outcome, showing that instead of 9 inches depth of rain being available, the amount is not more than 4½ inches over this contracted area. It results that London now requires a quarter of the actual outflow of the Thames for water supply.

NAME.

The river from Thames Head, near Cirencester, in Gloucestershire, has been rather capriciously named the Isis, until its junction with the Thames, 15 miles below Oxford.

LEVEL OF HIGH WATER.

The relative level at high water at Sheerness and London Bridge was fixed by Mr. Lloyd, by spirit leveling for the Admiralty in 1830. He deduced that at that time the tide attained a greater altitude by 2 feet at London Bridge; from a comparison of the oscillations of the tidal column at the two places, there is a greater range by from 4 to 5 feet at London Bridge, where the tide now ebbs at times from 12 inches to 2 feet lower than at Sheerness, due to the fact that the tide is still ebbing in the Pool when the flood is making at Sheerness, and continues to do so until met by the flood. Illustrative of this action, it is only necessary to point to Glasgow, where the spring tide rises as high as at Greenock, and ebbs 6 inches lower; and to the Tyne, where similar results occur. These cases might be multiplied by examples around our coasts.

MR. ROBINSON'S PAPER.

Reference may be here made to a Paper "On the Past and Present Condition of the River Thames," read before the Institution by Mr. Harry Robinson, Assoc. Inst, C. E., on the 22nd of February, 1856. Mr. Robinson referred to Cæsar's description of the river as "Alma" in his Commentaries; to the reference to its locks, etc., in Domesday Book; to the stipulations in Magna Charta for the removal of all weirs and obstructions, and subsequent edicts; that Queen Elizabeth directed special attention to its conservancy; the early condition of the estuary; the ancient name of the metropolis, "Llyn Din," or town on the lake; the difficulty of navigating the reaches above tidal influence; the practice of flashing at the weirs; the obstruction caused by water-mills at the locks; the large amount of tonnage—265,000 tons at the close of the last century, now mainly absorbed by the railways; the Acts of James the I. not acted on; that of George III. appointing commissioners for six districts into which the river was divided; the vast number of commissioners and unwieldy character of the body; the fact that at that time restriction upon making any lock below Maidenhead existed; the canal schemes of Brindley's time; to Rennie's report of 1794; and to Mr. Vanderstegen's successful crusade against the canal schemes, resulting in powers being given, in 1810, 1812, and 1814, to the Corporation of London to erect locks where required, and to the six pound locks erected by the late Mr. Leach between Penton Hook and Teddington, a distance of 15 miles, by which 21 feet out of 32 feet fall of water were penned up, all but the first having weirs with paddles removable in floods; and to the irregularities in the widths of the tidal reaches below, and the various embankment schemes to remedy this from the time of Trench, Martin, and Walker to the present time.

LONDON BRIDGE.

The first was built between A. D. 993 and 1016, in the time of Ethelred. This bridge was destroyed in 1136 by fire, and repaired, but in 1163 was in so ruinous a condition that Peter of Colechurch commenced the stone bridge, which was completed in 1209 under three citizens, notwithstanding King John's recommendation of one Isenbert, when Peter of Colechurch died or became infirm.

In 1280 the bridge became ruinous, and tolls for its support were authorized in the time of Edward I. In 1426 the draw-bridge and tower for defence were erected; in 1582 the water works were constructed; and after numerous fires, the great one of 1666 destroyed all the houses on the bridge, but they were again rebuilt. 1757-58 the houses were removed, a temporary bridge being built for the operation, and the large arches were formed subsequently.

TRADE OF LONDON AND MODERN WORKS.

The trade of the Port of London could never have been quadrupled in a century, from 1700 to 1800, quintupled in the succeeding half-century, and continued to increase in a greater ratio up to the present time, but for works regulating the channel and promoting and developing the tidal flow. To say that the river improvements cannot be greatly extended would be to take a narrow view of the subject; the dredging engine is the requisite agent, and doubtless the tide will maintain a much deeper channel than the minimum water hitherto existing over the shoals. This work is being actively prosecuted by the present Conservancy Board. Prior to their appointment, from the fact that only such material as was saleable, viz., gravel was dredged, a large arrear of work fell to the present authorities.

DELTA.

The variations of the sand-banks are constant. They are carefully buoyed and watched by the corporation of the Trinity House; the main channels marked by floating and fixed lights; and in addition, the lower reaches have been lighted of late years, where the half-tide fore shores, gradually increasing in width, obtain their maximum, viz., 5 miles, at low water across the Foulness or Maplin Sands of the Essex shores. To show the fluctuating character of the sands of the estuary, reference may be made to the modern buoyage of the "Prince's Channel," on the south side, which is now the main channel for outward bound vessels, having superseded to a great extent the use of the "Queen's Channel," to the south of it, which has 6 feet to 12 feet less water; also to the recent formation of a deep channel between the Girdler and Shingle Sands. And the Girdler Channel has been supplanted by a channel more to the north-east, between the West Girdler and Shingles, called the Shingle Channel up to the arrival of the Princess of Wales, who passed through it, and it has since borne the name of the Alexandra Channel. Also to the recent breaking through of Bullock's Channel, between the East Girdler and Long Sands, thus increasing its depth into the "Black Deeps" from 20 to 40 feet.

LOWER REACHES.—LOW-WATER DEPTHS.

The maximum low-water depths in the estuary give a good idea of the volume of water in the lower channels. In Sea Reach there is a depth of 60 feet; below the Nore 66 feet, and a similar depth in the Medway; but north of the dockyard the outfall has created a maximum low-water depth of 100 feet, shoaling again in an east-north-east direction to 19 feet. Between the Maplin and Mouse Sands there is a depth of 72 feet, and in the neighboring channels of 66 to 78 feet; in the Prince's Channel of 72 feet, and in the Queen's of 60 feet generally, and in the "Hole" of 105 feet.

ON THE BOTTOM-VELOCITY AND THE VELOCITY-SCALE OF RIVERS.*

BY J. SCHLICHTING.

In estimating the water masses of rivers, only approximate values of the velocity of the water immediately above the bed have yet been obtained, because the instruments in use do not permit of a direct measurement, and the theories relating to it are not universally accepted.

To remove this difficulty, to clear away doubts respecting the bottom velocity, and to find a law applicable to all streams, numerous measurements were made in the years 1873 to 1875 inclusive, and it has been found that the bottom velocity at any point can be determined where the velocity has been measured by instruments at two known points vertically above it.

With the exception of Hagen all recent writers on this subject assume the velocity scale to be a parabola with axis horizontal and under the surface, while according to observations of A. Gasse on the Elbe it has been found on the surface. The Author remarks that the results of the American experiments are founded upon an arbitrary grouping of experiments, and are consequently of no value, and that the only essential differences now remaining are whether the maximum velocity lies in the surface or below it, and whether the axis of the parabola is horizontal or vertical.

The Author used Woltmann's current meter for all measurements of velocity. For surface velocities one edge of the vane just touched the surface of the water, while the opposite edge was 7.8 inches (20 centimetres) below it, and the resulting velocity is regarded as that at the depth of 4 inches (10 centimetres). The velocities lower down were taken at intervals of 19.7 inches. Five cross sections of the Memel were taken near the bridge of boats at Tilsit, and were plotted on paper, the most suitable points being chosen for the velocity measurements, and marked by buoys. A pole 20 feet long was driven into the bed of the river, so that the current meter might slide up and down, and be suspended at any required depth by a light chain. Velocities were taken at 550 points in 130 different verticals. Each velocity was taken three times, during 100 seconds, and the arithmetic mean was adopted as the true velocity. The maximum velocity was found 80 times in the surface, or at the highest point of measurement 4 inches under the surface; 5 times simultaneously, in the surface, and 19.7 inches below the same; 35 times at 19.7 inches below the surface, and 10 times at 39.4 inches below the surface. The minimum velocity was found 125 times at the lowest point of measurement, and 5 times at points from 11.8 inches to 19.7 inches higher.

The Author concludes that the velocity continuall diminishes from the surface to the bottom, and that would follow a mathematical law if the irregularitie in the velocity of running water could be eliminated These irregularities near the shore produce whirlpools, sometimes even reversing the direction of the revolution of the vane.

Two Woltmann's current meters were used, and always showed small and variable differences, but similar small variations were noticed when a single instrument was employed. The Author attributes these irregular variations to the irregular motion of the water, and to the inaccuracy which always attends velocity measurements with the Woltmann meter, and to the imperfection of the instruments themselves.

He observes that the formulæ for determining the value of a revolution of the vane are open to weighty objections, and prefers to use the simple formula for the velocity of the water,

$$v = \beta n;$$

where β is the value of one revolution of the vane taken from a number of experiments in still water, and n the number of revolutions in a second of time.

He remarks that if the velocity of the boat used for

* From Abstracts of Papers in Foreign Transactions and Periodicals. Institution of Civil Engineers, London.

testing the current meter in still water be the same as the velocity of the stream to be measured, the above formula is the only correct one, and that in all other cases the unavoidable errors of observation render any co-efficient which might be introduced of little value.

If the motion of the water suffered no resistance from the friction of the bed, and from the pressure of the air upon its surface, the velocity scale would be a vertical straight line, because at all points the velocity would be the same, the pressure and the air being the same.

But on account of these resistances the motion of the lowest layer is retarded by the friction of the bed, and this retardation will affect the motion of the next layer, and so on to the surface. The retardation gradually diminishes from the bottom upwards, and the form of the velocity curve or scale would appear to correspond better with a parabola with its axis vertical and its vertex in the bed, than with a parabola with horizontal axis on or near the surface. The resistance due to the pressure of the air upon the surface of the water may modify the form of the velocity scale, supposing the air to be still; but no known instrument is capable of giving such small differences of velocity as would be required to establish this point. Floats will not suffice for this, because, besides their immersement, they have a part of their surface in the air, and their motion is affected by the resistance of the air; also they give only the mean velocity in a certain length, and not the velocity at any single point. It is probable that the resistance of the air at the surface of the water acts in the same way as the friction of the bed, but in a much smaller degree.

This would lead to the conclusion that the velocity scale was in its upper part a parabola with its axis horizontal and under the surface, and that this secondary parabola would meet the principal one in an unknown point not far below the surface.

This curve, composed of portions of two parabolas, may be the true velocity scale when water is flowing with steady motion, and the air is still;—the velocity scale being accepted as a parapola with its axis vertical, and its vertex in the bed.

After reviewing various formulæ, the Author sums up as follows;—

1. The mean velocity scale of rivers for each cross section, as long as it does not present any striking irregularities of depth, is a parabola with the axis vertical and the vertex at the bottom. The scale is obtained from average values of direct measurements of velocity, and consists of a rectangle contained by the mean bottom velocity as base, and the mean depth as height, and a semi-parabola of the same altitude. Two average values suffice to determine the velocity scale, and also the bottom and mean velocities, and the parameter of the parabola.

2. The maximum velocity in a stream, not influenced by wind, storm, ebb, or tide, lies in the surface or very near it, as well in the mean velocity scale as in the separate verticals, excepting those near the shores.

The maximum velocity is directly above the bed, and the mean at 4-9ths of the depth above the bed.

3. The velocity at any depth is equal to the bottom velocity increased by the ordinate of the parabola corresponding to the depth.

4. The ordinate of the parabola at 4-9ths of the depth above the bed is to that in the surface as 2 to 3, if the resistance of the air be disregarded.

5. The bottom velocity at any point depends on the fall, the depth, and the nature of the river bed. The value of the retardation is at least as great as the value of the ordinate of the parabola which lies in the surface.

6. In consequence of the variable bottom velocity, the relation between the bottom and mean and surface velocity cannot be constant either in different verticals or in the same vertical with different heights of water. Also the relation between the parameters of the parabolas belonging to the different velocity scales cannot be constant.

7. Such constant relations cannot be determined even by making use of co-efficients, because the latter vary more or less according to the resistance of the bottom.

8. The frequent change in the form of the velocity scale, based on the variable resistance of the river bed explains the unequal movements of the water in rivers. As long as the river bed is irregular and changeable no universal law can be determined for the motion of the water.

9. The methods hitherto used for the calculation of the water masses of rivers from the measured current velocities in various verticals and at different depths lead to inaccurate results.

Water masses may be more correctly calculated by dividing the cross section of the stream by vertical lines at numerous points, and determining only the mean velocity at each point at 4-9ths of the depth above the river bed, from the arithmetic mean of at least three observations, and then summing up the products of the mean velocities thus found, and the separate areas of the cross section.

The Paper is illustrated by two plates, one of which shows the five cross sections of the Memel taken near Tilsit, and the other contains diagrams in illustration of the velocity scales obtained from the measured velocities at the above cross sections.

LIGHTING RAILWAY CARS WITH GAS.

The *American Gas Light* of August 16th contains a long report of experiments on lighting Railway Cars in England with gas, and in its editorial columns publishes the following reference and quotation:

"In the proceedings of the British Association, in another column, we give a paper prepared by Mr. Sugg on the above topic. We urge a careful reading, and we cannot express our views on the importance of this subject better than is done by the London *Journal*, as follows—

"'We continue, to day, the publication of the papers read at the recent meeting of the British Association of Gas Managers. The lighting of railway carriages by gas is a matter of much interest to Gas Companies, since its general adoption would lead to a considerable increase of consumption. We believe that what has hitherto stood in the way of its more extensive employment has been the want of a tight holder, or, rather, a holder which would not allow of the inter-diffusion of gas and air. This want Mr. Sugg has supplied, and we now expect to see gas more largely employed on railways. To petroleum lamps in carriages we have a strong objection, and railway authorities, for more reasons than one, would be glad to get rid of the use of oil. If, then, gas be laid on at the stations in the manner pointed out by Mr. Sugg, the absolute economy involved in its employment will at once be appreciated. In the remarks we made, some time ago, on the use of Pintsch's compressed petroleum gas on the St. John's Wood line, we expressed no opinion as to the value of the lights. We simply invited our readers to go and see for themselves. We may say, however, to-day, that, in our judgment, the light is very inferior compared with that given by ordinary gas as employed on the Metropolitan line. Mr. Sugg shows, too, that in reality it is dearer; and all things taken into account it is probably more costly than Mr. Sugg makes out. It may be an advantage to be able to store under a carriage sufficient gas for twenty-four hours consumption; but, after all, the light afforded is the true test of value, and we consider that ordinary gas, even as now used, is a much superior mode of illumination. Gas companies may be thankful to Mr. Sugg for having given such a careful study to this matter.'"

About three years ago the same journal closed a description of a crude experimental apparatus for lighting cars with oil gas under the process of Prof. Pintsch, with the complaint "They are going far ahead of us in other lands." The strong appreciation of things ancient and foreign shown by the *Gas Light Journal* has doubtless prevented it from adding the fact, known to its editors, that some American railroads have for nearly twenty-five years, used gas for lighting their cars and have had, during all that time, holders that would retain the gas, and not allow "inter diffusion."

At a time prior to Herr Pintsch's experiment, one of our railroads, that had been using coal-gas for more than twenty years for this purpose, had already experimented, during a period of two years, with petroleum gas, and adopting the process and plans offered them, had constructed a complete and elaborate gas works and compressing apparatus, and applied the petroleum gas instead of coal gas to the illumination of their passenger cars. The results obtained have now during three years continuous use proved eminently satisfactory—furnishing a much better light for far less money. The saving effected by the change has been so great as to have already exceeded the entire cost of the gas works and compressing apparatus. They have found the especial advantages of petroleum gas over coal gas for this purpose to be:

First: Its greater ability to bear compression and extreme cold.

Second: The fact that a given quantity lasts so much longer than coal gas.

Third: Its lower cost.

Fourth: Its greater illuminating power.

The main feature of Mr. Sugg's English experiment is a bag of rubber cloth *forty feet long* to be carried on top of each passenger car. A wonderful improvement, truly, as compared with the neat, and compact apparatus of the Philadelphia and Reading, and other American railways.

In fact the whole paper in the light of our understanding of public comfort and safety, is ridiculous in the extreme.

Just imagine American passenger cars equipped with huge india rubber bags for top pieces and inflated with gas.

We fear that what has really "hitherto stood in the way" of lighting our cars properly, has not been the want of "a tight holder," or any English device; but rather the slowness with which railway companies adopt improvements tending to increased comfort, and safety, of their passengers, until pushed by the pressure of competition, and of public opinion. Then, too, the class Journals of this country might easily "express their views on the importance of this subject better," than by publishing extracts from foreign papers—more than twenty years behind the age—tending to show that car-lighting by gas is as yet, only a crude experiment; while the fact is, that the gas-works of at least one of our prominent railway companies, built especially for this purpose, (although used also for lighting its shops, depots, offices etc.,) are probably the most elaborate and complete private gas works in the world—and yet have saved more than their entire cost in less than three years.

These works were built, throughout, from the shops of the R. R. company itself, under the plans and patents furnished by J. D. Patton, of Hicksville, Ohio, who is also the builder of some gas works in this region. We cannot too strongly urge upon the railway authorities of this country, to improve their methods of car-lighting in some way. Candles are only sufficient to make the darkness visible, and oil lamps are both dirty and dangerous.

THE LONDON WATER-SUPPLY.

There are in London close upon 4 000,000 human beings, and the problem how this vast population can be supplied with water is full of difficulties. A paper on this subject was read in the section of Economic Science and Statistics of the British Association for the Advancement of Science at the recent Plymouth session. The conditions of a water-supply in any city ought to be, first sufficient quantity; second, a good quality; third, a high pressure; and, fourth, accessibility, so that the expense of the service may be brought within moderate limits. The present water-supply of London meets only the first and last of these conditions. Its impurity unfits it for use for drinking purposes, and the pressure is not high enough to secure the efficiency of the Fire Department. The supply is provided by eight companies, which have an aggregate capital of £11,196,000, a gross income of £1,137,000, and a net income of £705,700, giving a rate of interest on all the capital employed of proximately 6.3 per cent. The water is taken from the River Lea, and from the Thames above Teddington Weir. Its impurity has been attested by many chemists, and might be expected from the fact that the streams from which it is drawn drain a richly-manured country and many populous towns above London. The pressure will not afford on the average more than 2,000 per gallon at any fire, and this at the street level, where fire-engines will be required. "But there can be no question," says the report, "that to insure the prompt extinction of fires it would be in the highest degree desirable to be able to supply an effective jet from the water-main, without the intervention of an engine."

The remedy for the deficiencies is outlined in the scientific paper already alluded to, which was drawn up at the request of the Metropolitan Board of Works, and has been approved by such an eminent authority as the London *Times*. The plan is to have a double service,—one to furnish water for drinking, and for the

extinction of fires, and the other to supply water for washing, street-cleaning, and miscellaneous purposes. The companies now in existence would be charged with the latter work, while the corporation would undertake the former. The new supply would be taken from the vast stores which lie unused in the chalk formations fifteen or twenty miles distant from London. It is estimated that 16,000,000 gallons a day might be drawn from this source. The daily average quantity now used in London is 120,000,000, but it is believed that not more than 8,000,000 gallons are used for drinking and culinary purposes. The plan contemplates the building of reservoirs on the high ground to the north and south of London at a height of 400 feet above the level. These reservoirs would be supplied by pumping engines drawing their supply of spring water at distances of from eight to fifteen miles beyond the reservoirs. The reservoirs would be united by large arterial mains traversing London from north to south. Service pipes would take the water into the houses, delivering it into a close vessel having a draw-off tap, and containing, according to the size of the house, from three to ten gallons, and filling up gradually after having been emptied. The annual cost of the plan proposed is thus stated: Interest at 3½ per cent. on £5,500,000, £192,500; working expenses for pumping and management, £32,500; total, £225,000. This would be equal to about 2¼*d* in the pound on the ratable value of the metropolis. It is estimated on the other hand, that the expense of buying up the privileges of the present companies and adding the pumping facilities required for fire purposes would be £26,000,000, and the annual running expenses £1,612,250, equal to about 16½*d* in the pound on the ratable value.

The advantages of the new scheme are apparent, but it is open to serious objections, one of which the London *Times* has noticed. The supply of 16,000,000 gallons daily will not be sufficient when the wants of the country about the chalk-beds increase, as they promise to do, and their supplies are taken from this source. It may be doubted also, whether the average householder can be depended on to save the chalk-bed water only for drinking and cooking. On the other hand, the adoption of the plan would remove at once all difficulties as to the existing companies, and would furnish a supply for the extinction of fires under an enormous pressure, so that the reduction in rates of insurance might in a short time cover the expenses of the alterations. It is understood that householders would always have the choice whether they should use the turbid Thames water or the pure water from the chalk-beds, or both.—*Chicago Tribune.*

BOOK NOTICES.

THE POCKET GEOLOGIST AND BOOK OF MINERALS. By Fred. H. Smith, Civil and Mining Engineer. Baltimore, Md. Price $1.00.

This book though unpretending in appearance, fully justifies its title, and for those who take pleasure in geological studies or pursuits, we know of no more convenient or portable *vade mecum* on the subject.

The author neither wastes time nor space in introductory matter, but proceeds at once to the consideration of elements, thence to minerals, rocks, veins, metals ores, carbons, gems, spars, limes, clays, grits, salts and paints, all of which are treated as fully as the limits of the work will allow, the principal facts relating to each topic being succinctly stated, and a great deal of information condensed into a narrow compass on the inexhaustible subject of geology.

THEORY OF TRANSVERSE STRAINS and its Application in the Construction of Buildings. By R. G. Hatfield. New York: John Wiley & Sons. Chicago: Janset, McClurg & Co. Price $6.00.

This work is a genuine surprise. It is so seldom one finds an architect who is thoroughly posted in what may be termed the "Engineering" of Architecture, that we may well be pardoned the above expression. This is not a compilation merely, it is more. It is the result of the investigation of an intelligent architect, and is a monument to his industry and ability. There is no similar work in the language, and although intended apparently exclusively for architects, will be also useful to engineers.

Speaking of "headers" it is stated that "the cutting, or mortising, of the header should be confined to the middle of its height." This is eminently true, yet the general practice is to cut two mortises. There is one consideration not noticed, and that is the liability to split along the length between the mortising.

The use of stirrup iron is also strongly advised. Floor beams, girders, etc. are considered, and their various uses, conditions, etc., discussed and almost every point of view or condition is brought forward. It, perhaps, might have been better to have left some portion of the subject to be mastered by the reader. The graphic method is applied to solid beams and its use well shown. We think, however, it might have been simplified; instead of making the polygon of strains for each force and then from these the general polygon, the general polygon might have been made at once by means of the equilibrium polygon. The subject of bridging floor beams is discussed and its effects well shown.

The subject of iron beams and girders is considered at length, and now that their use is so general in buildings, is apropos. The principal authority previous to the issue of this work, was the information embraced in a paper written by the author of this book under consideration, and read before the American Institute of Architects years ago. We are glad to hear from him again on the subject. Rules for the tubular girder and also for cast iron girders are given; but the best rule for a cast iron girder, (unless of a few feet span) is not to use them. They are treacherous things to deal with.

The subject of Framed Girders is discussed, and graphical methods are shown. The use of the equilibrium polygon is, to a certain extent, shown, but not as fully as it might, (we had almost said it *should*); the different forms of trusses are given, but in all cases the loads are taken as vertical, though not always symmetrical. A very ingenious, and to us novel, graphical method of determining the reactions at the support is given, when a truss is loaded on both upper and lower chords, and the loads are not symmetrical, though in the examples given in this book they are all vertical. It would take too much space to report it here. There is a simpler method of attaining the same end by means of the equilibrium polygon, by making a separate polygon of forces and an equilibrium polygon for each set of loads, then after finding the point on the closing lines of each polygon of forces which divides the closing lines into the amounts of the reaction at each support, superimpose these polygons on each other, so that these two points coincide and the relative directions of the forces are maintained, this will give a complete polygon of all the forces and the strains in the members may then be got as usual. This method is correct, although the directions in which the loads act may vary from each so that there may not be any two loads which act in a parallel direction. The work closes with a series of tables of the strengths of the various materials used in building.

We lay down the book with the feeling that the author has filled a gap in architectural literature and done it well. It may be rather prolix, but that is the necessary out-come when a writer loves and appreciates his subject and naturally desires to show its every shade.

A CARD.

To the voting members of the American Society of Civil Engineers:

Your attention is respectfully invited to two facts, viz.:—

1. The committee which submitted at the Ninth Annual Convention at New Orleans the draft of a memorial relative to metric weights and measures was appointed under the following resolution,

Resolved: that the American Society of Civil Engineers will further by all legitimate means, the adoption of the Metric Standards in the Office of Weights and Measures at Washington, as the sole authorized standards of weights and measures in the United States; that the Chair appoint a committee of five to report to the Society a form of memorial to Congress, in furtherance of the object expressed; and that the foregoing be submitted to the Society and voted on by letter ballot."

So far as the chairman can judge he fully believes that the members of the committee were unanimous in the opinion that it was their duty to report a form of memorial suitable for presentation to Congress; a memorial whose adoption by the American Society of Civil Engineers would further the adoption of the Metric System as sole standard in the United States; and that all means proposed to be employed by the Society must be legitimate.

2. The U. S. Standard weights and measures are preserved in the U. S. Coast Survey Office, Bureau or Office of Weights and Measures, in charge of J. E. Hilgard. In a letter of 19 Nov. 1875, Prof. Hilgard writes, "About the functions of the Office of Weights and Measures in Washington, I write next week;" and in a letter of 21 Nov. 1875, "The U. S. Office of Weights and Measures owes its existence to the fact." etc., and "This Bureau or Office is thus a branch of the Treasury Department and part of the Coast Survey Office."

(Signed). CLEMENS HERSCHEL,
Member American Society of Civil Engineers.
BOSTON, *September 7*, 1877.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Saginaw Valley & St. Louis R. R. intend building a new bridge over the Tittabawassee river, Michigan.

The Grand total cost to Hamilton county, Ohio, during the year ending the 3d inst., of bridges and culverts built and repaired, was $37,801.39.

The Pacific Bridge Co., of San Francisco, have just completed a bridge in Oakland, Cal., 1236 feet long, and 60 feet wide, at a contract price of $28,330.

A company is being formed to bridge the Ottowa river at New Edinburgh, Ont., for street railway and by-way purposes. The estimated cost is $300,000.

The Philadelphia Bridge Works of Cofrode & Saylor, at Pottstown, Pa., are finishing up a bridge for the Philadelphia & Baltimore Central road at Chadd's Ford on the Brandywine, and have also several highway bridges to build.

The new iron bridge over the Connecticut river, constructed to unite the north end of Springfield and the centre of West Springfield Mass., was formally opened on the 5th inst. with a procession, which included 100 carriages, and a subsequent clam bake, with informal speeches. The bridge cost $150,000, and was built by the Leighton Bridge & Iron Works Co., of Rochester, N. Y.

GAS AND WATER-WORKS.

The new pipe foundry of D. Giles & Co., Chattanooga, Tenn., is completed.

The city council of Ottawa, Ont., have agreed to abolish the Board of Water Commissioners.

Water taxes in Montreal, are said to be some $30,000 in arrears, as compared with last year. Bailiffs have been specially appointed this year to enforce the collection.

According to the Rockford (Ill.) Weekly *Register*, the fuel for the water works in that city, during the month of August cost $67.65, and the cost for pumping each million gallons during the month was $14.92.

The Toronto, Ont., Water Commissioners are talking of having a display of that city's system of water works at the Provincial Exposition next year. Their Engineer claims that no city of equal size in Europe has so efficient a system.

An exchange says: "They have a water works ring in Pittsburgh so energetic that it stops up the mains so as to produce a water famine, that shall lead to an appropriation for new improvements that shall provide better stealing for the members of the ring."

The machinery of the new water works of the Indianapolis stock yards, will consist of one of Dean Brothers' best duplex steam pumping engines, with all the necessary attachments, with capacity for furnishing 1,000 gallons of water per minute; and sufficient force to throw four streams 100 feet high. For fire protection, the yards will be provided with about 8,000 feet of street mains, with hydrant attachments, and provisions being ample to protect all the buildings against fire.

At a meeting of the Board of Water commissioners of Toronto, Ont., last week Mr. T. C. Keefer, Canadian commissioner to the Paris Exposition, appeared

before the Board, and suggested to the commissioners the advisability of having a map prepared showing the progress of the water works of Toronto and have it shown at the Paris Exposition. As supplementary to his remarks, Mr. Keefer read the following letter, which he had addressed to the Board; "I beg to bring under the notice of the commission the propriety of an exhibit by them (in connection with the city) of the water works of Toronto. The works between the Esplanade and the Lighthouse Point present features of exceptional interest. The filtering basin, the wooden and iron pipes, are on a scale which has not been surpassed, if equalled, anywhere. In respect to the whole work Toronto will compare most favorably with any other city in the world of the same population, and therefore should, I think, be represented at Paris next year. Plans, sections and photographs are all that is required to exhibit the works, and upon them all the necessary statistics may be shown." While the members of the Board were all favorably inclined towards the plan it was decided to discuss the matter more fully at another time.

RAILROADS.

A party of engineers are at work locating the line of the Montreal, Ottawa and Western railway between Aylmer and Quio, Ont.

Railroad building is very active in Minnesota. It is asserted that within a year seventeen railroads will be either finished or begun in the State.

Ten tons of nitro-glycerine, for use on the Fort Francis Canal and Section 15 of the Canada Pacific railway, arrived in Winnepeg, Canada on the 2d inst.

Red cypress is believed to be the best wood in the world for railroad ties. Some red cypress ties on the Louisiana and Texas road have been down seventeen years and are still sound.

J. Wainright, Engineer of the A. & G. W. R. R., and Charles Davis, Chief Engineer of the new Youngstown & Pittsburgh railway, with a corps of assistants are engaged in surveying the line of the Lake Erie route from Youngstown, Ohio to Hazeltown.

The surveying force in the employ of the projectors of the Miami Valley and Columbus narrow-gauge railroad, via London, have run the proposed route as far as Solon, Ohio. It is now thought that the construction of the road through the course indicated is a certainty.

The Lawrence (Kan.) *Journal* says: "The Searcy railroad in Arkansas consists of four miles of wooden rails laid on a natural roadbed. The equipment is one car; the working force is one man; the motive power is one mule, and the fare from the outside world to Searcy is $1. There was no strike on the Searcy railroad."

The Minister to Mexico has transmitted to the Department of State a report upon the railoads of that country. American cars and engines are superseding the English. The want of railroads is acutely felt throughout Mexico, and the subject of concessions for their construction will be a leading topic at the next session of Congress.

D. S. Whittenhall, the inventor of the iron railway tie described in No. 17 of the present volume of ENGINEERING NEWS, has, during a recent absence in Kansas, Nebraska and Colorado, secured contracts, for a number of his ties, from the Kansas Pacific, Atchison Topeka & Santa Fe, Denver & Rio Grande, and Colorado Central Railroads. They will be rolled in this city as soon as possible and forwarded to the Railroad Companies before enumerated who will make a thorough trial of their merits during the coming fall and winter.

The equipment of the Billerica & Bedford, Mass., twenty-four inch gauge railroad consists of two engines, weighing eleven tons each, with coal and water aboard; two passenger cars, of from four to four and one-half tons each; two excursion cars, 5,500 pounds each; one box freight car, 5,600 pounds; six flat cars, 4,500 each and two hand and two push cars. The cost of the locomotives, with the new tender attached forming the forward part of the locomotive, is $3,500 each. The passenger cars, holding thirty persons each, one on either side, are six feet wide, furnished with saloons, and one having a compartment for mail and express matter. Their cost is $2,000 for one, the other costing $1,800. The other cars cost in the aggregate about $2,400, making the equipment of the road to cost $13,200. All the passenger and freight cars are provided with the Miller platform and air brake, with other improvements. The length of the road is eight and one-half miles. It was completed and opened for traffic on the 31st ult.

MISCELLANEOUS.

Work will probably begin upon the Moon Island sewer in Boston, the first of October.

The diving of bathers in Upper Kings river, Cal., revealed the fact that the bed was rich with gold.

The Hayden survey has carefully located all the peaks of the Wind River Mountains north of the fortieth parallel.

It is estimated that turbine water wheels have since their invention, saved the country over $300,000,000 in the one single item of fuel.

Present indications are that Capt. Eads, will secure the payment of his next installment of half a million dollars, from the Government, without difficulty.

It is computed that France now possesses steam engines of an aggregate force of 1,500,000 horse power. This is equal to the effective labor of 31,000,000 men, or about ten times the industrial population of the country.

Chicago is trying the plan of "still" alarms for fires. The chief of the fire department has allowed no bell ringing since the recent riots, and the plan works well. Great crowds at fires are prevented and better work is done by the unhindered firemen.

The exportation of American wines to Europe is rapidly increasing. The Centennial made the Europeans acquainted with the excellence of some portions of our vintage, and the demand for the better brands for transatlantic shipment is large.

Macon, Ga., has an Ice Factory that makes 10,000 pounds of ice daily, at a cost to consumers of one cent per pound. This is about the rate paid in Savannah, where there are two ice companies who get their supplies from the natural manufactory.

In boring the artesian well at the Insane Asylum, St. Louis, the auger penetrated 3,800 feet, going through 200 feet of coal measures, 500 feet of sub-carboniferous limestones, 1,000 feet of Devonian, and 2,000 feet of upper and lower silurian, and in the bottom cut a brown ferruginous sandstone, supposed to be of Potsdam age.

In a large number of letters written by William Penn to various persons in America, from 1682 to 1687, in the Historical Society's rooms, and in the original charter of the City of Philadelphia, in 1670, also in a letter, to J. Harrison, in Independence Hall, written in 1684, also in various other letters and manuscripts, Pennsylvania is invariably spelt Pennsilvania.

Subterranean telegraphy is receiving much attention in Europe. Germany has seven underground lines between its capital and its western frontier, and recently another one on a great scale has been laid between Berlin and Mayence. The cost of these underground cables is about six times more than the overground wires, but the advantages are considered much greater, and in time of war are invaluable.

The great French engineer, M. de Lesseps, who has become famous as the builder of the Suez Canal, expresses an opinion that the Zamberi and Congo rivers can easily be connected by a canal at the point where they approach within eighteen miles of each other, thus affording water communication across the entire continent of Africa. Another great project of his is the proposed railroad across Asia, which is favorably considered by the Russian Government.

The difficulty of the street car companies in getting full returns from both conductors and passengers is not confined to this country, although it has probably produced a greater variety of bell-punches, clock monitors and patent deposit boxes here than abroad. The London General Omnibus Company, was so much exercised upon the subject two or three months ago, as to offer a reward of £1,000 for an invention or scheme for effectually checking passenger fares, and it is not known yet that even such incentive has developed the requisite ingenuity. Some of the devices used in New York and Philadelphia, have already yielded considerable revenues to their owners; for one of them a single car company is said to have paid $25,000.

The National Tube Works Co., at McKeesport, Pa., have recently manufactured some of the largest and longest tubes ever made. They were fifteen inches in diameter and thirty-two feet long, and are intended for a steamboat now being constructed at Louisville. They have also made ten twelve-inch flues, thirty-six feet in length for a rolling mill at Youngstown, Ohio. The contract for flues for a steamboat at Louisville, fourteen inches in diameter and thirty-four feet in length, was awarded to Morris, Tasker & Co., of Philadelphia, but the work was not satisfactory, and a new contract was made with the National Tube Works. In less than six days after the order was received the tubes were made, shipped, and placed in position on the boat.

A very important and extensive piece of sewerage work,—known as the Mill-Race and Fillmore-Parkway Sewer—is now in progress of construction in Buffalo, N. Y. Its total length is 11,143 feet, the whole number of acres drained at the outlet being 4,562. The improvement is divided into six sections the size of the first being 12 by 9 feet; the second 10 by 6½; the third 7½ by 5 and egg-shaped; the fourth 7½ by 5, bench walls and arch; the fifth 7 by 4 feet 8 inches, egg-shaped, and the sixth, 6 feet 3 inches by 4 feet 2 inches. Work was begun about the first of last month and some two hundred men are at present actively employed. A. H. Delamater, of Cleveland, Ohio, is the contractor for the work, his bid of $78,600 being the lowest of the four which were received, a year's time being allowed for its completion from the date of commencement. The work is under the general supervision of City Engineer, Geo. E. Mann, Assistant Engineer Edward B. Guthrie being directly in charge.

The extension of the north pier at the entrance of the harbor at Grand Haven, Mich., is well advanced toward completion, and when finished will be 150 feet long, 30 feet wide, and 26 feet in depth. The timbers used in the construction are 12 by 12 and 12 by 18 inches square, and are framed and bolted together in the most substantial manner, using over fifteen tons of iron bolts. The cribs when sunk in the lake are filled with stone, requiring some 480 cords, which is brought from Chicago in barges. Mr. James Colwell of New York, is contractor; Mr. James Bartlett, of Detroit, foreman, while Capt. Mower, United States Government engineer, has the immediate supervision of the work, which is expected to be completed during the month. The cost of this public improvement will be about $20,000, and will no doubt be of great benefit to this important harbor.

The work upon the tunnel under the Hudson river, between Jersey City and New York, which has been delayed for some time by litigation, it is now stated will be resumed early in the fall. A shaft twenty-eight feet deep has been dug at the foot of Fifteenth street, Jersey City, and this depth will be increased twenty feet. From this as a starting point, the tunnel will proceed in a northeasterly direction under the Hudson river and the Christopher street ferry slip. The entrance on the New York side will be in the neighborhood of Washington square. From Jersey City the grade will decend two feet in every hundred feet, until a point 2,700 feet from the New York side is reached, when it will begin to ascend at the rate of one foot in every hundred feet. The tunnel will be two miles in length, with a roadbed twenty-three feet wide, and two separate tracks. Through its entire length it will be lighted by gas. The wall will be constructed of brick, with a thickness of four feet. At no point will the top of the tunnel be less than thirty-five feet below the surface of the water, and in many places it will be seventy feet below. One hundred and twenty laborers will be engaged in the consruction of the tunnel. The work will go on during the whole of the twenty-four hours, the force working in three relays, of eight hours each. Although the tunnel will be used for the conveyance of passengers, its main object will be the transportation of freight to and from the great railroad lines which terminate in Jersey City. The capital of the company is $10,000,000.

OUR RAILROADS AND THEIR ECONOMICAL USE.

VI.

In determining what is cheap transportation for any section of the country, we must consider all the conditions under which it must be conducted; the distance from markets, and which of the three means compared in the last paper can be used to perform the service. Let us examine some of the cases which occur. Case 1st. The distance 10 miles to market, and common roads the only available or possible means; 15 cts. per ton per mile would not be considered extortionate. It is also clearly evident that we cannot compare this service with railroad or water transportation for the reason, that for that locality but one method of transportation exists.

Case 2d. The distance 100 miles to market, and accessible both by common roads and railroads at 3 cts. per ton per mile; when either can be adopted, the former at 15 cts. per ton per mile, or the latter at 3 cts. per ton per mile; the comparison can be made and the cheaper selected.

Case 3d. Take for the distance 100 miles or more, accessible by common roads, railroads and water route, with the latter at 1 cent per ton per mile. These three can be compared and the cheapest taken.

The vagueness which has arisen in our minds in regard to what is cheap transportation, is from our attempting to compare the rates of each from localities where all the means are not accessible and not possible.

The conditions which affect the cost of such service are so unlike, that the rates of each system are not comparable, that is—we cannot compare kinds of service which do not exist. It is perfectly evident that we may compare the rates of freight from Chicago, Milwaukee, Detroit, Toledo and Cleveland to Buffalo or New York, both by rail and water a portion of the year. The kinds of freight, time of transit, interest and insurance, would determine which means of transportation would be selected. The bulky or heavy freights would go by water. The rate which would pay a fair compensation for water transportation per mile would not pay on railroads which had to be constructed at great expense. The difference in investment of the two means of transportation precludes the rates of one being as cheap as the other, but the latter is not available in and to all sections of the country; ½ cent. per ton per mile is a fair compensation for ocean rates on a large portion of the freight, but we can never expect such rates for inland commerce, when the expense of constructing the means of transportation is so much greater. It is not possible to construct artificial water channels to take the place of railways, for they have taken the place of the canals, as being much superior in every respect, for the latter could not do the business of transportation as rapidly and promptly as required.

Take any inland city, say Springfield, Ill., without water communication to New York; we cannot compare its rail with water rates, for the same distance, for to them the latter does not exist; it is one of their conditions of locality, and they and similar places must consider the expense of preparing for, as well as performing the service.

We cannot all live in Chicago, Milwaukee, Detroit, Toledo, Cleveland, Buffalo or the great chain of lakes, where for part of the time we could have a choice in rates for freight. St. Louis has water communication to the ocean via New Orleans, yet she sends large quantities of corn and wheat by rail to the seaboard via Baltimore. Inland cities cannot expect, with railroads constructed at such vast expense in crossing the country over valleys and through mountains, that it will be possible to reduce the cost of transportation upon them to ocean rates. Upon the through lines, where the volume of business is great, they have not been able by the most economical management in practice to reduce the cost of transportation per ton per mile below 1 cent, though some have reported it as low as three-fourths of 1 per cent. Yet when all expenses which properly belong to transportation are paid, we must consider it at a very low rate at 1 cent. Our railroads have been constructed according to the knowledge which their builders possessed, and it is not surprising that many serious errors have occurred, aside from what may be termed dishonest management, and these cannot be remedied in a day. No matter how much capital may have been expended in the construction of a road an error to a certain extent becomes a tax upon its business either to its patrons or owners.

In considering what is cheap transportation by railways, the interest paid on the investments as an entirety must be taken as some index to the cost of such transportation. In Poor's Manual we find data for the following table, which shows per road mile per centage of stock, bonded debt, other debt, and rate of dividends upon stock of the roads in the United States, divided into groups as seen below, for the year 1875:

	Per cent. of Stock.	Per cent. of Bonds.	Per cent of other Debt.	Dividends.
New England States....	54.73	35.75	9.52	4.94
Middle States.....	49.63	44.90	5.47	5.69
Western States	46.14	48.48	5.33	1.99
South and South-western States	41.71	48.43	9.86	0.61
Pacific States.....	54.94	43.42	1.64	0.00
Pacific R. R	36.47	62.73	0.80	8.38

Although a very condensed table, it shows several important matters, when taken in connection with the other tables heretofore presented. The railways in the New England States taken as a whole have paid less than 5 per cent. upon their stock, which is much below the legal rate of interest in the majority of the States, and less than the community at large considers a fair rate of interest taking the risks into consideration. Most of these railroads have been very expensive to construct owing to the rugged and mountainous topographical features. The large percentage of stock, shows that these roads were well appreciated by the communities. The investments in stock of this group of States singly is as follows: Maine, 37.72 per cent.; New Hampshire, 67.24 per cent.; Vermont, 50.61 per cent.; Massachusetts, 54.12 per cent.; Rhode Island, 47.68 per cent.; Connecticut, 69.01 per cent. When the stock subscriptions are large, the bonded debt is small in proportion, consequently there is not so much required to pay the interest upon the bonded debt, and the dividends should be correspondingly increased. In the Middle States the dividends were larger than in the New England States, being some 5.69 per cent., which is not an excessive rate of interest. In this group, though business to and fro between the country and its chief metropolis has its effect in increasing the dividends, in the other sections of the country railroad dividends have been small (except the Pacific R. R.), a large majority not paying anything, while a number of roads defaulted the interest on their bonds, and passed into the hands of receivers. Taken as an entirety—has the railway system paid a fair investment upon its capital? Most certainly not. If we examine the systems of other countries we find that upon the whole it has not paid as well at other business schemes. It is quite common to hear of the reckless management of our railroads, which is true to a certain extent, but it must be remembered that there is no other enterprise of so recent origin of such magnitude, and all must learn as we proceed. From our present standpoint we can see many improvements which might and must be made before much further advancement is made in the progress of transportation. The West has built more roads than are needed at the present time for her business, and the burdens have fallen heavily upon them, and seem grievous to be borne. Time has not been given for new business to develop, but the old volume of traffic was expected to be divided between the competing lines, and to be sufficient, at much lower rates, to furnish the means of existence for all, which was clearly impossible.

The character of the business in the West differs from the East. Of the gross earnings in 1875 in the New England States 54.94 per cent. was for the transportation of freight and mails, and 45.06 per cent. for passengers.

In the Middle States	76.79 for freight.	23.21 for passengers.
" Western "	73.33 for freight.	24.67 for passengers
" Southern "	72.32 for freight.	27.68 for passengers.
" Pacific "	70.15 for freight.	29.85 for passengers.

As the various sections of the country became more thickly settled the increase for passengers will be a much greater per cent. than now.

THE ELECTRIC CANDLE.

The announcement of the invention of the electric candle, and the publication of its description, in the early part of this year, created temporarily quite a panic in the value of gas shares in England, as there was the apprehension among the holders of that class of property that M. Jablochkoff's discovery would supersede the use of coal gas as a means of domestic illumination. We gave some account of the contrivances used, at the time when they were first given to the public, and much interest has since been felt by scientific men as to whether the electric light could now be brought into general and economical use. Experiments on a considerable scale were conducted in Paris, and at the West India Docks in London, to test the value of the invention, and the results have not been satisfactory. The illumination was found to be sufficiently powerful, indeed screens and shades must still be used to render the light endurable, but the candles had to be renewed every twenty or thirty minutes, when, unless a duplicate set had been previously lighted, the place would be left for a short time in darkness; the expense of this light much exceeds that of gas.

A French journal of good authority contains a carefully tabulated statement of the cost of lighting the Salle Marengo in the Magasins du Louvre, now lighted by eight electric candles, in place of seventy-four globe burners formerly used, showing that the total cost of the electric light is four times as great as that of the gas light, and that, as gas is used during a part of each evening, the combined means of lighting costs more than five times as much as gas alone.

The Journal of Gas Lighting says that Mr. Backler, an English gas manager, who went over to Paris to investigate this invention came back from the continent with the conviction that the 'electric candle' at present is a delusion. He guards himself carefully however, from expressing a confident opinion as to its future. On one point he and we are both confident. The 'electric candle' can never be a domestic institution. The present defects, indeed, so clearly stated by Mr. Backler, render it inapplicable for any practically useful purpose, other than that for which the Holmes and Siemens light is employed. It is, in fact, little more than a scientific curiosity, and will long remain nothing else. We need not, however, close our eyes to the possibility of further developments. Science is not stationary; but until an entirely novel source of electricity is discovered gas will find no competitor in that force; nor even then unless means of modifying and controlling that force are found, which are today beyond even the reach of speculation.

We commence this week the publication of a most valuable paper on the "Various Methods of Consolidating Earth that has slipped," translated from the French of M. Comoy, by Col. Merrill, of the U. S. Engineers in charge of the Improvements on the Ohio, Monongahela and Little Kanawha rivers. The subject is one of great importance and interest to engineers, and we feel sure that our readers will feel greatly obliged to the eminent translator, who, from his own personal experience, may well be considered an authority as to the value of the paper which he has so very kindly undertaken to present to the profession.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

VII.

(*Continued from page 249.*)

WHO MAY BE ADMITTED TO PRACTICE.*

About twelve young men put in an appearance at Toronto as candidates for the title of P. L. S. on the first Monday in January, 1863, of whom the writer was one. They were a genial good-natured lot of fellows, who had mostly all seen about the same kind of work

* See page 171 ENGINEERING NEWS.

in field and office, and had an abundant supply of surveying adventures to relate for mutual benefit and entertainment. All but two had served the regular three years apprenticeship, while from various causes several of the number were up for final examination the second time. There were also other students occasionally dropping in, to see who were present, to relate their own experiences and grievances, and to help the class pass away the rather tedious hours of each day. These were "passed" students, whose diplomas were withheld by the Board until certain conditions were complied with, such for instance as the non-possession of a theodolite, which on account of poverty or other reasons the student had not seen fit to purchase.

The Board rooms are two in number, and in the inner sanctuary with closed doors, the dread tribunal sat, and from the dusty archives of the ancient institution drew forth the dingy little slips of paper over which preceding classes had wearied their brains and worn out their pencils, or from the pages of those abstruse old masters Gillespie, Euclid, Chambers' Course, or perhaps Snowball and some of the other ancients, they with united wisdom, selected new questions, which were duly written out, and through the very agreeable and justly popular secretary, Unwin, transmitted to the class in the outer court. Calculating the contents of an irregular field of anywhere from 17 to 29 sides, by Gillespie's General Rule was a favorite resource for killing time, to relieve it of sameness occasional problems in astronomy involving all the rules and formulæ in spherical Trigonometry were sent out; we have no doubt that the intelligent experts in the inner room worked hard and earned each his five dollars per diem for the thirteen days that we were kept busy listening to each others yarns of camp life in the woods; to tales of former examinations and to other interesting gossip that consumed about five-sevenths of the entire time, the only relief being when the over-worked Secretary paid us occasional visits with fresh cargoes of question papers. Who would imagine that common land surveying—the ability to run a straight line through a swamp or over a prairie, and to chain it, and to calculate the area of a square field, or of a triangular one, was so abstruse and mysterious a science that it required the combined wisdom of four such mighty intellects as would naturally compose the quorum of the Board of Examiners, together with one Secretary to record the results, for the period of thirteen days to find out whether a class of twelve young men of average education and three years field practice, knew how to go through the necessary operations of running such a line or calculating said areas. The strain on the intellects of those devoted servants of the Dominion must be very severe, and we do not wonder that they grow old prematurely. What is the labor of a poor professor of Mathematics or Engineering in any college, who takes a class of thirty, and in eight or twelve hours decides upon their qualifications, when compared with the trials of the faithful Dominion Board, who have to tax their brains (and the government treasury) for thirteen long days to pass a class of twelve? We think the pay is too small a recompense for the task which is imposed on the mental and physical systems of the gentlemen at Toronto and Quebec who have the responsibility of turning loose upon the farmers of Canada the quarterly squad of surveyors who are to determine their boundaries, and it would be but a simple act of justice to these gentlemen for the government to divert an additional moiety of the surplus revenues from the sales of timber limits to their adequate compensation.

A part of the thirteen days was taken up by the oral examination of each student, who was summoned to the only sight which he obtained of the Examiners, who of course would have no time to spare from the diligent study of Gillespie in search of "puzzlers," or the deciphering of the solutions of the questions returned from the class, to look in upon the aspiring youths who were chewing plug tobacco and comparing naughty stories in the adjoining room.

My turn came and at the summons of the secretary, I found myself confronting the men who had imposed upon me a whole year of expense and loss of time, and who had the power to repeat the dose. One lively old man with a face like the Iron Duke's and much more bronzed from exposure, I suspect, and who wore upon his head a long, and bright red cap, such as French Canadians delight in, took me in hand at once. "Mr. P. L. S. what is a function?". "Function of what, sir," I enquired as meekly as I could; the iron-faced old inquisitor was about to explain I suppose, when a sudden thought struck him; he pulled off his red fez, and donning his overcoat and cap remarked that he must catch the next stage for dinner, left me, and as I have never seen him since, I am yet in the dark as to the particular function he was after.

A bald-headed, benevolent looking old gentleman who occupied another chair, smilingly remarked that it was his hour for lunch, and immediately departed from the room leaving me to be interviewed on the subject of my professional knowledge by a dapper little fellow who seemed to be head over ears in business, and who evidently imagined that *he* was the Board, and the Board was *he*, and without *him* there was not any Board, and to tell the truth I do not think he ever will let the Board be bereft of his presence. I sat quietly while this gentleman filed away innumerable papers, wrote several slips, put his desk in order, and finally summoned me to his side. The easy way in which that man talked of sines and cosines, and parellelograms, and trapezoids; latitudes and logarithms, and the familiar knowledge of the surveyor's Act, and the great variety of intricate problems in surveying, of which he was possessed was quite wonderful, and I am still at a loss to know how "one small head could carry all *he* knew." But the most amazing circumstance was how a rather pleasant and polite secretary should in two years become such a contemptible martinet of an Examiner as this one had. We feel sorry for that poor man.

(*in our next.*)

LIST OF PROVINCIAL LAND SURVEYORS IN ONTARIO.

James Anderson; Charles Ambrose, retired; George Frederick Austin, Ottawa; George B. Abrey, Manitoulin Island; Charles Fraser Aylsworth, Madoc; William Robert Aylsworth, Jamesworth; James Allan, Renfrew; John Sidney Aylsworth, Odessa, Lennox and Addington; F. W. Armstrong, Orillia; J. B. Bedard; Pierre Beaupre; George Bruce, Osnabruck, Aultsville, P. O.; JesseP. Ball, Vienna, Ont.; John S. Bruce, Cornwall, Custom House, R. au Raisin; Thomas A. Blyth, Hamilton; William Burke, Norwood, Asphodel, retired; George A. Ball, Belmont; Onesiphorous Bartley, Sandwich; George Boyce, Erie, Pennsylvania; Josiah Barris; James William Bridgland, Toronto, Crown Land Department; John O. Brown, Toronto; David R. Brown, Osnabruck, Dickinson's Landing P. O.; Arthur Bristow, Pawley; John Burchill, Mirrickville; John Smith Brown, Matilda; William Boultbee, India; Andrew Bay, Clinton P. O.; Crosby Brady, Lindsay; Joseph William Burke, retired, Prescott; Walter Beatty, Delta P. O.; Samuel Brodie; Henry Carew Boulton, Toronto; Arthur Boultbee, Uxbridge, Barrister; Thomas Charles Brownjohn, Grimsby Township; Robert Taylor Burns, Kingston, Clerk in Post Office; William Bell, Pembroke; Edgar Berryman, St. Catharines; Peter Burnet, Atherly; Thomas Burns, Hamilton, clerk in Post Office; James Brady, Montreal; Thomas Byrne, Sombrea P. O.; Francis Bolger; Leslie Charles Battersby, Guelph; John Donald Baikie, Dunnville; Thomas Olliver Bolger, Peterboro; Andrew Bell, Greenville, Que.; Edgar Bray, Oakville; Jesse Nunn Boulton, BoltonVille Albion P. O.; Lewis Bolton, Listowell; David Beatty, Delta; William Burke, Cobourg; Harry John Browne, Toronto; William Brown, Orillia; Josiah John Burrows, Ottawa; Frank L. Blake, Toronto; Thomas Caldwell, Michigan, U. S.; Angus Cattanack, Lancaster, Dalhousie Mills; James Cleaver, Nelson; Peter Carroll, Hamilton; Edgar Clements; Henry J. Castle, King's Col., London, Eng.; John O. Conger, Picton; C. Batstone, Thunder Bay P. O.; James A. Bell, Chatham; Wm. A. Brown, Toronto; J. L. Bowman, Berlin; R. N. Bonfellow, Weston; Samuel Bray, Collingwood; Joseph M. O. Cromwell, Perth; Edward C. Caddy, Cobourg; Henry Creswicke, Sr., Barrie; Thomas Chessman, Mitchell; Vincent Mutius Clementi, Peterborough; Theodore Bold Clementi, Peterborough; Frederick J. Chadwick, Guelph; Thomas Walter Cooper, Guelph; Cyrus Carroll, Walkerton; Libert Chandler, Goderich; Cyprian Francis Caddy, Seymour Township; Henry John Cambie, Ottawa; Henry Creswicke, Jr., Barrie; Henry Carre, Belleville; Richard Plunkett Cooke, Brockville; Chas. Finlayson Chapman, Prescott; David Loutter Campbell, Mitchell; John St. Vincent Caddy, Sarnia; Walter Crowe, Chatham; Arthur John Crickmore, Toronto; Allan G. Cavana, Orillia; Cozens, Meaford; Jos. A. Cotton, Ottawa; Jas. A. Carbert, Orangeville; Jean B. Demers; Marie des de Glondon; Jno. Dennison, Goderich; Thomas J. Dennehy, Norwood; Edmund De Cew, Cayuga; Jno. S. Dennis, Ottawa; Jno. D. Daniell, Australia; Thos. Devine, Toronto, Crown Land Department; Michael Dean, Lindsay; Alfred Driscoll, C. E. Sherbrook, Chas. Lennox Davies, India; Thos. Donovan, Meaford; Thomas Wm Dobbie, St. Thomas; William Drennan, Ireland; John DeCew, Cayuga; John Daintry, Cobourg; Alexander Davidson, Arkona, Warwick Tp.; Joseph Doupe, St. Marys; Richard Holmes Donnelly, Orillia; Thomas Winning Dyas, London; James Dickson, Fenelon Falls; H. C. Denny, Toronto; Michael R. Egan; John Emerson, Roslin; William Henry Ellis, England; James Hutchinson Esten, Toronto; Samuel Thos. Abbott Evans, Pembroke; John Dunlap Evans, Belleville; George Edwards, Clarence Co., Russell; Wm. Case Eaton, Carlisle Co., Wentworth; Zenas Fell, Merrittville; Charles K. Fell, Pelham; James W. Fell, Chippewa; Edward T. Fletcher, Quebec; Charles Fraser, Wallaceburg; Sandford Fleming, Ottawa; Edward Fox, Toronto; Alfred Guy Forrest, City of Ottawa; James Wm. Fitzgerald, Peterborough; John Fleming, Collingwood; John James Francis, Sarnia; Thomas Featherson, Milton; Albert Fowlie, Orillia; George Henry Frost, Chicago, Ill.; Frederick Lucas Foster, Windsor; Cosford Chalmers Forneri, Thunder Bay P. O.; John Fair, Markdale; P. P. Fairbairn, London, Ont.; Louis Guy; John Galbraith, Michigan; Valentine Gill; Thomas F. Gibbs, Adolphustown; William Galbraith, Brock, Manilla P. O.; John Grant, Mitchell P. O., Tp of Logan; James A. Gibson, Oshawa; Robert Gilmour, Toronto; Peter Gardener, Paris; Brooks Wright Gossage, Toronto; William Grain, Fergus; Peter Silas Gibson, Willowdale, York Tp.; George Gibson, Petrolia; Wm. Ewbank Gaitskell, London, Eng.; Edward Forbes Gaitskell, Streatham, Surrey, Eng.; Edward Gardiner, St. Catherines; Maurice Gaviller, Bond Head; William Sinclair Gore, Gores Landing; Thomas Gilliland, Priceville; John Galbraith, Port Hope; James F. Garden, Woodville; James Hall, Peterborough; Daniel Harvey, St. Thomas; James Hamilton, London; John G. Howard, Toronto; William Harley; Andrew Hood, British Columbia; John J. Haslet, Rawdon Tp.; Robert Hamilton, Hawkesburg; Henry Hodge Horsey, Ottawa; William Haskins, Hamilton; Joseph Hobson, Berlin; Alfred Howitt, Stratford; Skee'er William Hallen, England; Thomas Hughes, Napanee; Latham Blacker Hamlin, Kincardine; Royal Wilkerson Herman, Listowel; Wm. Hawkins, Walkerton; Clement George Hanning, Uxbridge; Patrick Kennedy Hundman, India; Milner Hart, St. Marys; John Harris, Oxford Mills; Wm. James Shea Holwell, Toronto; L. A. Hamilton, Collingwood; Patrick Ivory, New Castle; James Moore Irwin, Port Hope; Robert Jones; Francis Jones, Kemptville; E. R. Jones, Sarnia; Quintin Johnston, Brantford; Silas James, Toronto; Geo. Bell Johnston Jr., Township of Moore; John Henry Jones, Sarnia; James Kirkpatrick, Hamilton; Thomas Kelly, Castlemore P. O.; Robert W. Kerr, Hamilton; Thomas C. Keefer, Ottawa; Joseph Kirk, Stratford; Ed. Henry Kertland, Toronto; William Kingsford, England; Geo. Brownley Kirkpatrick, Toronto; Lachlan Kennedy, Toronto; Thomas Kains, Lindsay; George M. Kingston, Toronto; O. J. Klotz, Preston; Asa Landon, United States; Robert Lynn, Meaford; James Lyons, Pembroke; Henry Lillie, Lyn P. O., Elizabethtown Tp; Hamilton Lowe, Nanticoke; N. E. Low, Nanticoke; John Lindsay, Quebec; Thomas C. Livingston, Hamilton; Mathew Lough, Port Hope; Henry Lawe, Dunnville; Wm. H. Lovett, Lapenotiere, Elora; John Goodenough Lynn, New York; Hugh David Lumsden, Woodville Co., Victoria; James Stewart Laird, Chatham; F. H. Lynch; Robert Watt Lendrum, L'Orignal; Pierre Marcoullier; Duncan McDonnell, St. Raphael P. O., Glengarry; William McDonald, New Castle, Gaspe; Eliakim Malcolm, Oakland; John McNaughton, Charlottenburg, Glengarry; Andrew Miller, Rochester; Robert McDonnell; Jacob

Misner, Welland Port; William McMillan, London; Wm. McCleary, London; Michael McDermott, Chicago; John R. McDonell, Williamstown; Archibald McNab, Owen Sound; Roderick McLennan, Thunder Bay; John Morris, Perth; Peter McLaurin, Riceville, S. Plantagenet; George Mc Phillips, Fort Garry, Man.; John Maxwell, Paris; James McCallum, Jr., Pefferlaw; Thos. Molesworth, C.E., Toronto; Jas. McIntosh, Strabane; Alex. McDonald, Montreal; Wm. Mc Connell, Ottawa; Wm. Mercer, Simcoe; F. C. McCallum, Mt. Albert; Hy. Augustus F. McLeod, Belleville; Wm. John McDonald, Arnprior; Moses McFadden, Mornington Township; Sherman Malcolm, Rond Eau; Allan Hay McDougal, Bowmanville; Christopher Mc Lennan, Chicago; John Joseph McKenna, Australia; SamuelOwen McGuin, Loughboro P. O.; John Murray McGrigor, St. Mary's; Francis Murphy, Mount Forest; John Molloy, Arthur; Charles Falconer Miles, Thunder Bay.

(To be continued.)

REPORT ON VARIOUS METHODS OF CONSOLIDATING EARTH THAT HAS SLIPPED.

BY M. COMOY.

Inspector General (Retired) of Ponts et Chaussees.

Translated for ENGINEERING NEWS by Brevet Col. Wm. E. MERRILL, U. S. A.

PREFACE.

It is often necessary in public works to deal with land slides. They are found on natural hillsides as well as in excavations and embankments.

These accidents generally occur in earth where clay predominates, and especially where the argillaceous masses have been softened at several points by water that has gradually filtered through.

There are some argillaceous hillsides whose surface cannot be broken even by a shallow ditch without starting a movement that sometimes extends to great distances. Such slips often give rise to the most serious disturbances. Ditches are filled either by the fall of the side slopes or by the rise of the bottom, and sometimes structures are entirely overthrown. In some places the argillaceous hillsides are in so bad a condition that they begin to move after heavy rains even without being started by a ditch, carrying with them roads, plantations, and buildings. Therefore engineers, when they encounter such hillsides while laying out a road of any kind, hasten to modify their line in order to avoid them if possible; and this is the best thing that can be done.

It is not necessary that argillaceous hillsides should be under such extreme conditions as those just named in order to produce slips in the side slopes of excavations made in them. Such accidents are extremely common.

Similar slips also take place in the slopes of heavy embankments made of argillaceous earth. These could be avoided, at least in most cases, if these fills were made of horizontal layers of earth heavily rammed and if the argillaceous layers were separated as much as possible by stony or gravelly layers. But this method of constructing embankments leads to heavy expense, and it is most probably for this reason that it is seldom used. In many works, and especially in the construction of railroads, the fills are made of full height from the start. With such embankments we must expect slips of the slopes wherever the earth of which they are built is chiefly argillaceous.

It is not necessary to add that this last method of constructing embankments is absolutely inadmissible in canal work. The object of these works necessitates special care in construction, and this renders slips of the slopes much rarer. They do, however, occasionally occur in canal and reservoir banks where the earth used was not of the quality required, and where it was insufficiently rammed.

We ought therefore to expect that either from natural causes or from imperfection in methods of construction, slips will continue to occur in argillaceous earths, and engineers will always have such to repair.

The study of the steps to be taken to make substantial repairs and to prevent the recurrence of these accidents is therefore of real importance.

I had occasion, during my career as an engineer, to observe a certain number of accidents of this kind that happened under different circumstances. Various methods of repair were adopted; and if all have given satisfactory results, they have not always done so with the same facility and the same moderation in cost.

I thought that it might be useful to collect these observations into a report which, at the same time, would afford an opportunity of comparing the different methods used.

The following are the accidents which I describe in this report:

1. Land slides on the hillside of the right bank of the Allier above Vichy.

2. Slips of the hillside of Avrilly adjacent to the canal from Roanne to Digoin.

3. Slip of the hillside of La Négresse, adjacent to the railroad from Bayonne to Irun.

4. Slip of the side slopes of excavations and embankments along the railroad from Paris to Lyons and the Mediterranean.

5. Slips in the Bréval cut on the railroad from Paris to Cherbourg.

6. Slips of the interior slope of the embankment of the Cercey reservoir of the Burgundy canal.

7. Slips of the interior slope of the embankment of the Torcy reservoir of the Central canal.

The first chapter of this report will be devoted to the description of the accidents just named, and of the works of repair occasioned by them.

In the second chapter I will present some observations upon the works described in the first chapter, and I will point out the practical rules which may be deduced from them.

To collect the material for this work I had to address myself to the government engineers, and to those of the railroad companies, under whose care these accidents fell. They all answered my requests with promptness, and gave me, in the most obliging manner, all the documents in their possession. I take pleasure in expressing my gratitude in this report.

CHAPTER I.

DESCRIPTION OF THE WORKS FOR THE REPAIR OF SEVERAL SLIPS IN ARGILLACEOUS SOIL.

1st. Land-slides on the hill-side of the right bank of the Allier above Vichy.—From time immemorial the hillside on the right bank of the Allier above Vichy for a length of about 6 miles, has been subject to extensive movements, especially after heavy rains.

This hillside, about a mile and a half wide and 650 feet high, is composed of middle tertiary earth, resting on primitive or transition beds. The line on the surface which separates the middle tertiary earth from lower strata very nearly coincides for a large portion of the length of the hillside with the watershed of the valleys of the Allier and the Sichon.

The middle tertiary earth dips at the bank of the Allier, and reappears on the left slope in the beds of little streams. On this slope it is covered either by the alluvial deposit of the Allier or by the upper tertiary.

In excavating its bed in the bottom of the valley the Allier has cut through the middle tertiary earth whose upper layers form the abrupt and moderately high left bank.

These upper layers, inclined with the same slope as the hillside, and unsupported at the foot, are thus badly situated for stability and they have been altogether broken up. After heavy and long continued rains, these clay soils begin to move at many points, carrying with them whatever may be on the surface. The village of Abrest has many times seen its existence menaced, and some of the houses nearest to the Allier have already fallen into the river.

In 1856 after the rains which caused such disastrous inundations, the movements of the hillside were very considerable and National Road No. 106, built parallel to the course of the Allier, and at a distance from it of more than half a mile, was torn up for a considerable part of its length.

It would have been altogether insufficient to have limited the work of repair to restoring the profile that existed before the slips. Such reloading would undoubtedly have made the earth slide still more. The engineers understood this thoroughly and therefore they first attacked the slips themselves. They did not restore the road until after the works for consolidating the soil were finished.

The sliding of the argillaceous earths which form the upper layer of the hillside appear in all cases to have taken place on the calcareous beds of the middle tertiary earth, which is found at a depth of from 10 to 25 feet.

To stop these slides the engineers thought that it would be well to subdivide the masses in motion, to procure a ready discharge for the water within the soil, and as far as possible, to prevent the water flowing on the surface of the soil from penetrating within it.

It was with these views that the works of consolidation were planned.

The subdivision of the disturbed earth appeared to be an especially necessary operation. It was thought that it would be very difficult, if not impossible, to construct an obstacle in front of the moving earth, and that to have some chance of success, it would be advisable to divide these masses of earth along the lines of greatest declivity of the hillside, so as to be able to act on each one of the partial masses thus isolated from each other, either to stop an existing movement, or to prevent any in the future.

As a means of dividing the masses of sliding earth, blind drains filled with stone were used when the depth did not exceed 15 feet; below this depth masonry culverts provided with flap-valves to draw off the confined waters were substituted for blind drains.

The drains as well as the masonry culverts afford a ready discharge for all the water that can penetrate the soil.

The cure was completed either by encircling ditches dug beyond the limits of the slip, or by drainage works on the surface of the slipped earth.

The width of the stone filling varied from 2½ to 4 feet, and its height from 3 to 10 feet. The depth of the trenches varied from 10 to 20 feet.

It follows from this that the trenches were not filled to the top with stone. There remained above the top surface of the stone an empty ditch from 7 to 10 feet deep.

The trenches for the drains were dug with the consent of the land owners, but without purchasing the land occupied by them. As the land of this hillside is very valuable, the owners, in order to restore them to cultivation, filled the excavations that were left open above the stones.

It does not appear that the filling of these ditches has altered the result obtained by the construction of the drains.

These works, which were executed between 1857 and 1862, occasioned a total expenditure of about $8,000.

The documents on file do not give the total lengths of the different slides as measured along National Road No. 106. Consequently I cannot determine the average cost per running foot, as I have done for the other works described in this report.

However the total length of the slides certainly exceeded 1300 feet. The cost was therefore less than $5.00 per running foot.

The works were completely successful. No slip has occurred at these places since they were finished.

(To be Continued).

Written for "Engineering News."

THE METRIC DISCUSSION.

III.—CONVENIENT UNITS.

An objection to the introduction of the metric system among engineers is that the actual weights and measures proposed to be used are not (it is alleged) of convenient magnitude, and they are contrasted unfavorably with the units now generally employed.

The temptation presents itself to illustrate this by the old story of the king who always called for his old shoes, because they fitted better than new ones; but, on reflection, the comparison would be unfair; for, whatever superiority in all other respects the new shoes may have had over the old, the complaint that they were not so exactly formed to shape of the wearer's foot was undoubtedly true; which would be too much to say for this argument against the metric system.

Let us examine the items of the charge. The basis of the new system is the metre; the present British standard of length is the yard, equal to 0.9144 m. or about $\frac{10}{11}$ of a metre. If one-tenth of its present length

should be added to his measuring stick, does any one suppose that the American counter-jumper would flourish it with any less dexterity? The yard is used by engineers chiefly for cubic measurement (though for masonry some antedeluvians speak of the perch, which is a little less than a cubic yard and is somewhat elastic, the real Simon Pure having the extremely convenient magnitude of 24¾ cubic feet). One cubic yard equal 0.7645 cubic metre (about ¾); if one is serviceable, the other is also. The actual measure found in the hands of every artisan in the United States is not, however, the yard, but is the much vaunted 2 ft. rule, divided into 24 inches. Its length is 60.96 centimetres. A half metre rule is so nearly of the same length that it is sometimes mistaken for 2 feet. A 60-centimetre rule is almost precisely the same length, and 60 has a greater variety of integral factors than 24 even. But ⅗ of a metre is not the standard unit, nor is $\frac{6}{10}$ of a metre. No, neither is ⅗ of a yard the British unit. The foregoing is by way of argument, to silence opponents; the friends of the metric system report that the four-fold metre with hinge joints and the ten-fold lap-jointed metre are quite satisfactory. Gunter's chain, which has been found so perfectly adapted for field use during the last two or three centuries that it is known as the surveyor's chain, is 66 feet long, equal 20.117 metres. Probably a 20-metre chain could be handled, then, with tolerable facility. The kilometre (3281 feet) is very nearly the same length as the Russian verst, which may comfort people who remember that the verst is connected with the British Imperial standard and is exactly 3500 feet. For vertical measurement a German engineer states that the metric division is preferred to the decimals of a foot; because with ordinary sights a leveling target cannot always be set twice to the same thousandth of a foot. That division ($\frac{1}{10}$ of a millimetre) is unnecessarily fine. The millimeter is just about as small as is wanted. In leveling we simply measure down from the plane of the instrument, the absolute length of our rod is immaterial. But if a pole is wanted for horizontal measuring, instead of 16½ ft. (=5.029 meters) we might use 5 metres.

"	16	" (=4.877	")	"	5	"
"	12	" (=3.658	")	"	4	"
"	10	" (=3.048	")	"	3	"
"	6	" (=1.829	")	"	2	"

In draughting or in iron work what unit could be more convenient than the centimetre?

Several of the metric weights and capacity measures vary comparatively little from units we are now using, as is expressed in tabular form below. The standard weights for packages of goods are not always the British units, by the way. Spices and other small groceries are frequently put up by the manufacturers, in quarter pound and half pound packages, the pound apparently being considered rather too large for some goods.

Approximate Equivalents.	Metric Weights.
Apothecaries scruple	= 1.296 Gram.
¼ pound (avoirdupois)	= 1.134 Hektogram.
1 Net Quarter (25 lbs.)	= 1,134 Myriagram.
Barrel of Flour (196 lbs.)	= 0.889 Quintal.
Gross ton (2240 lbs.)	= 1.016 Ton.

Metric Capacity Meaures.	Approximate Equivalents.
Deciliter	= 0.845 U. S. Gill.
Liter	=1.0567 U. S. liquid Quart. / =0.908 U. S. dry Quart.
Dekaliter	= 1.135 U. S. Peck.
Hektoliter	= 0.839 Barrel (of 31½ U. S. gallons.)
Kiloliter.	= 1.049 Tun (of 8 barrels.)

Each metric capacity measure is printed on the same line with the weight of water which it holds.

It is rather wearisome to go through with all the details. The general fact, of course, is that in human experience it is required to measure quantites of all possible magnitudes ranging from microscopic minuteness to astronomical immensity; and that if we select a particular set of units like the inch, the yard and the mile we find them perfectly adapted to certain classes of measurement, and somewhat less convenient for intermediate purposes. Seamen, for instance, see fit to use the fathom, which is not a part of the established series; it is about the length which a man hauling in a line can reach with once outstretching his arms. Horse-jockeys use the "hand," which is more than an inch and less than a foot (and happens to be almost exactly one decimetre). If we adopt a different set of units, as the centimetre, the metre, and the kilometre, they may not be quite so handy for the purposes best fitted by the British measures, but they will be superior for some to which the British are not perfectly suited. Take as an example the measurement of clothing for the human body. Our hats, gloves, collars, socks, etc., are numbered in inches and fractions, especially fractions. Collars are manufactured of various lengths, the successive sizes increasing by half inches. The inch is too large an interval. If collars were made for each integral centimetre in length, we should have just the series required, and be rid of fractions. All who have observed the necks of our fashionable youths during the past year will admit that the dickey is a subject of no small magnitude.

Rather than lose the chance for a little argument, however, let us suppose for a moment that for all engineering purposes the metric units really were somewhat awkward. Would that be any sufficient reason why engineers should try to block the wheels of a reform which promises the greatest blessings to the public generally? It is not for the columns of ENGINEERING NEWS to depreciate the importance of our profession; we are very select, if you choose; but numerically we are few; and of all classes in the community ours is the one which from constant familiarity with all sorts of measurement and computation is particularly well able to get along with a refractory system of weights and measures. If it were necessary we might with great credit yield a little for the sake of simplicity and universality in the language of quantity. If, forgetful of our relations with other people, we should look at this question from a narrow and selfish point of view, we should be acting in much the same spirit, which has contributed to produce the present confusion in our metrology. The disposition of each class of business to adopt whatever weights and measures it likes, regardless of others, has conspired with local customs and variations, and with the difficulty of making exact copies of standards, to produce some remarkable results. When we were boys we had to learn apothecaries weight, surveyors' measure and cloth measure, most of which, happily, we have now forgotten. The cloth measure contained the ell English, the ell French and the ell Flemish. In Europe different towns and countries had their own weights and measures; it is even reported that in one town certain weights and measures were used on one market day, and a different standard on the next market day, later in the week. Dr. F. A. P. Barnard, the learned president of the American Metrological Society, has enumerated 388 different weights called a pound, varying from 192 grams to 1068 grams, and in countries, excluding Scandinavia, which have now adopted the metric system, he has a list of 252 measures formerly passing under the name of "foot," extending with small intervals from 235.06 millimetres to 649.33 millimetres.

Such is the weakness of human nature that possibly we may yet have a variety of attachments and excrescenses engrafted upon the metric system; but if we don't sweep away the existing incongruities and start with a clean score, let us hope, for the honor of the profession, that it may not be the fault of the engineers of the United States.

THE RIVER THAMES.*

BY JOHN BALDRY REDMAN, M. INST. C. E.

(*Continued from page 251.*)

UPPER REACHES.

Upwards, the water attains a depth of 55 feet above the Nore, 30 feet in Leigh Road, 48 feet south of Chapman Sand, 61 feet off Holy Haven, 61 feet in Sea Reach, 30 feet off the Lower Hope, 33 feet off the Mucking, 53 feet in the narrow part of the Hope, 49 feet off Coalhouse Point, 56 feet in Gravesend Reach, the same in Northfleet Hope, 52 feet off Grays, 44 feet in Fiddlers Reach, 43 feet off Greenhithe, 40 feet in Long Reach, 25 feet in the Rands, 34 feet off Erith 30 feet in Erith Reach, 25 feet off Rainham Creek, 22 feet in Half-way Reach, 21 feet in Barking Reach, and 19 to 21 feet in the Gallions.

The navigable depths are usually lower from shoals; but the above enumeration indicates that the minimum low-water channel may be much developed. The upper reaches to Woolwich have a general low-water channel of 20 to 15 feet deep; and upwards to London Bridge of 10 feet.

*A Paper read before the Institution of Civil Engineers, London.

METROPOLITAN REACHES AND EMBANKMENTS.

The condition of the metropolitan reaches had been but little improved notwithstanding the multitude of suggestions to ameliorate a state of things which became, from the number of questions involved, more and more difficult to deal with each succeeding year. The first comprehensive plan was that by Sir Christopher Wren, after the fire of London in 1666. In 1767 an embankment was carried out by Mylne on the Middlesex shore in conjunction with Blackfriars Bridge. The well-known terrace of Somerset House by Sir William Chambers, the Adelphi Terrace and embankment in 1770 by the brothers Adam, and the Millbank embankment, in 1830, complete the list of such works above bridge, until the formation of the embankment in front of the Houses of Parliament. To these may be added the commercial quays on each bank below London Bridge and at the docks, the Greenwich Hospital and Pier embankments, Cubitt's embankment of the Isle of Dogs, and the quays at Deptford and Woolwich Dockyards. Beyond these but little had been done in the way of any comprehensive embankment measure until the agitation of the question by Trench and Martin, the laying down of lines by Walker, Bullock, and Leach, and the partial completion of the work by Sir Joseph William Bazalgette, M. Inst. C.E., who has also nearly completed the other great work of the day, the diversion of the drainage of London to the lower reaches of the river at Dagenham and Plumstead. It is the fashion with Englishmen to sneer at works at home. Much was said of the Seine when the Thames Embankments were first projected. It is suggested that the Thames Embankment is the greatest metropolitan improvement of modern times, and is unrivalled in any city of Europe. Certainly the resultant effect, whether viewed from the river or the bridges, is finer than had been foreseen by any of its early and most sanguine promoters, except perhaps in the characteristic sketches by the painter Martin.

To show the neglect of the river prior to these improvements reference may again be made to the Commons' report of 1793, the Committee directing particular attention to the fact, that with the exception of various Acts for the improvement of the river, and numerous schemes with the same object, no regular survey or plan of the river had ever been made, nor had any systematic scheme of improvement been acted upon.

SEWAGE.

Before the diversion of the metropolitan sewage another altered condition of the river had been entailed; for what under the old statutes of sewers was illegal, became consequent on the introduction of a more plentiful water supply and modern appliances, gradually legalised, viz., the connection of house drainage with the sewers, originally laid out only to carry off the rainfall of the valley, termed by Callis in his well-known work "a fresh water trench compassed in on both sides with a bank, and is a small current or little river." The work of Roger Griffiths, the Water Bailiff, of 1746, dilates on "the Beauty and Value which the River of Thames is to the Publick." He refers to the extent of its navigation and shipping, the nursery it forms for seamen, and "the invaluable blessing we have in its fishery," and says lovingly, "it far exceeds all other rivers in the known world. Should not," he appealingly adds, "such a River be therefore carefully preserved from all Obstacles and Damages that may occur either to its Navigation or Fishery?"

THE TIDES.

Unusual ranges of tide due to gales, and the double tide from similar causes, naturally attracted attention from an early period, when the low-lying parts of London were subject to floods. Holinshead and Stow described them, and in Gough's Topography a paper was published describing a double tide, which occurred on Friday, the 4th of February, 1641. The river banks were overflowed in 1099; in 1114 the tide ebbed so slow that persons walked on either side, and under London Bridge; the same circumstance is recorded in 1158; on the 10th of Feb. 1238, Westminster Palace

was flooded; in 1242 the banks were burst, and the country under water for 6 miles; in 1270 this again took place; Stow records that Westminster Hall was flooded on the 30th of September, 1555; on the 26th and 27th of January, 1564; there were double tides; on the 6th of November, 1574, a high tide burst the banks, and a reflux after an hour's ebb occurred; in 1607 and 1641 double tides occured; and in the first year the river was frozen over.

Pepys mentions that of the 7th of December, 1663, thus:—"I hear there was the last night the greatest tide that ever was remembered in England to have been in this river: all Whitehall having been drowned." Taking the levels of the lowest parts of Whitehall, this height was possibly from 3 to 4 feet above Trinity standard.

On the 13th of December, 1717, the tide ebbed so low, with a violent westerly wind, that persons again walked across, and under London Bridge. On the 31st of December, 1732, a high tide overflowed Wapping, Tooley Street, etc.; on the 9th of February, 1762, the banks were overflowed; on the 10th of March, in the same year, the tide flowed into Westminster Hall; on the 13th of February, 1763, this again occurred, covering the floor to the depth of 4 feet (this would be 3 feet 2 inches above Trinity standard); and on the 18th of November of that year there was a double tide. On the 28th of September, 1764, the marshes were again overflowed and cellars filled; on the 10th of April, 1768, the "sand banks," described as existing on each side of London Bridge, are said to have been dry. On the 2nd of February, 1794, a high flood tide overflowed both banks above Westminster Bridge; in Palace Yard it was 2 feet deep:—"Boats came through the passage of old Palace Yard from the Thames and round up to Westminster Hall gate. The two Scotland yards, Privy Gardens, Whitehall, were under water, and many parts rendered impassable for two hours. Westminster Hall suffered much; the water ran in at the great door for upwards of an hour, and was up to the second stair leading to the Court of King's Bench." This would appear to have been from 2 to 3 feet above Trinity standard. The devastation caused by the above tides was due, no doubt, to the bursting or overtopping of earth banks before wharves had become general.

FORESHORE BEACHES.

There is curious evidence from these old records that there was a river beach, as it were, on either side of old London Bridge, where the tide was checked; and a similar thing is observed at the present day. The Author has frequently walked along and noticed the variation in the wasting away and re-accumulation of a beach of small pebbles in front of the terrace embankment of Greenwich Hospital, lying in the deep bight fronting the Isle of Dogs. He has also repeatedly noticed the same thing whilst engaged on dock and wharf works in the neighborhood, at the head of the long reach on the western side of the Isle of Dogs, where a natural beach of small pebbles and sand forms on the top of the mud foreshore, as at Greenwich and along the Lambeth and Millbank shores.

GRAVESEND TIDES.

From a register kept by the Author at Gravesend from 1842 to 1845, he found the extreme range of tide to be 24 feet 6 inches. A high tide on the 18th of October, 1841, estimated to be the highest on record for half a century, rose one foot higher than any of those observations, giving an extreme range of 25 feet 6 inches.

The highest tides occur with gales from the north-north-west to north-west, which, acting on the large area of the North Sea, cause a great accumulation of water at the mouth of the Thames, and an increased lift of tide. The tide of 1841 rose

3 feet	3 inches	above	Trinity	standard	at Woolwich.
3 "	4 "	"	"	"	Blackwall.
3 "	6 "	"	"	"	Westminster.

At Blackwall on the—

12th December, 1845, it rose 3 feet 4 inches above Trinity standard.

24th January, 1850 it rose 3 feet 4 inches above Trinity standard.

12th November, 1852 it rose 3 feet 7 inches above Trinity standard.

15th February, 1854 it rose 3 feet 5 inches above Trinity standard.

22nd December, 1863 it rose 3 feet 6 inches above Trinity standard.

24th November, 1866 it rose 3 feet 4 inches above Trinity standard.

1st March, 1869 it rose three feet 4 inches above Trinity standard.

The highest of these, that of November, 1852, exceeds by 4 inches that of 1841, giving an extreme range of 25 feet 10 inches at Gravesend.

The tide of the 20th March, 1874, was 9 inches higher, or 4 feet 4 inches above Trinity standard, which increases the range to 26 feet 7 inches; and the highest tide of all, that of the 15th of November, 1875, was 4 feet 9 inches above Trinity standard, making a total range of 27 feet.

It may be noted that the two great tides of the 15th of November, 1875, and of the 2nd of January, 1877, occurred in each case the day after a gale from the west, raising the Channel sea to an almost unprecedented height, and which would require three tides, or 20 hours, to complete the circuit of the English coast before its full effect would be felt in the river Thames.

TIDAL IRREGULARITIES.

Lord Anson in 1756 described, in the "Philosophical Transactions," the irregularities of the tides caused by a shift of wind and gales, during and after which there is an extraordinary acceleration and subsequent falling off of the tide. This was shown during the gales of October and November, 1859. On the 26th of October there was a difference of 3 feet 10 inches between the morning and afternoon tides, and of 3 feet 8 inches between the afternoon tide and that of the morning of the 27th, and 3 feet 7 inches between two succeeding tides in the gale of November. This difference of nearly 4 feet in the rise of two succeeding tides, and amounting in some cases to 6 feet, is exceptional, and due to rapid change of wind during gales. The amount was 7 feet 5 inches on the 8th of January, 1839, and on the 21st of October, 1874. A comparison of these variations at Sheerness with London is confirmatory. In some cases they are almost identical. Usually they are less at Sheerness, and the variation of the barometrical pressure is generally sympathetic, but not always so. In most cases these great differences have occurred during, and more especially after, changing gales of wind, and it will be obserevd that 3 to 4 feet is the ordinary difference in level. In cases of extreme variation this may exceed 7 feet, or one-third the total oscillation of spring tides.

SHEERNESS AND LONDON.

The existing great difference in the range of tide between Sheerness and London shows how much low water has been lowered at the latter. When Mr. Lloyd took levels in 1830 low water was estimated by him as 1 foot 8 inches higher. It now ebbs lower than that of Sheerness, and the high water now ranges 3 feet 10 inches higher that at Sheerness.

Captain Maughan, for many years Dock Master at the London Docks, determined by his tables that the maximum range of tide in the Pool had considerably increased as the rise of springs.

	Feet.	Inches.
In 1800, fixed by the Trinity Corporation was	18	0
" 1843 it was	19	6
" 1864 "	20	4
" 1866 "	20	8
" 1875 and now	22	0

EFFECT OF EMBANKMENTS.

The future improvement and development of the resources of the river are dependent on works that will increase and not check the tidal range; that will regulate the widths and depths of the low-water channel, and generally encourage the tide upwards. Respecting the effect of the Thames embankments as yet constructed on Walker's lines, there is, even among those having the best opportunity of forming a judgment, a very diverse opinion. The Royal Commission gave a guarded opinion as to the results to be anticipated, and suggested that if detrimental, compensation reservoirs might be formed higher up the river, to store tidal water and return it on the ebb. Reservoirs of this type were constructed about sixty years back on the Channelsea river a tributary of the Lee, with self-acting swivel pivot gates to the sluices, with one-half of the leaf farther from the centre (on the Dutch plan); but they were seldom used, and were abandoned by the Lee Commissioners under their last Act. It must be obvious that the value of riparian land within the tidal range is so great as to render the construction of such reservoirs, which would have to be more than 50 acres in area, very costly; and the alternative is presented whether, if compensation be necessary (which is not, however, for a moment suggested), another method more conducive to the interest of the river might not be adopted, viz., not the extension of lockage downwards for the local benefit of towns on the verge of the tidal flow, but tidal extension upwards, by the removal of Teddington Lock, and dredging and regulating the stream above and below it. Has the abstraction of the 50 acres or thereabouts reclaimed by the Thames Embankment, in front of Whitehall and the Adelphi, and along the Lambeth shore and at Chelsea, covered at high water by a mean depth of 6 feet of water, representing about 365,000 tons passing down upon the early ebb, produced any sensible effect? or has this been compensated for by the dredging of shoals and the deepening of the low-water channel below? Or have the embankments compensated for this abstraction by raising the tidal column and causing the high-water level to reach higher in the reaches above these works, and so produced an equivalent for the water formerly overflowing the reclaimed slobs? Two opposite opinions are held on this subject. Some persons argue that not only does this abstraction of water deprive the river of a valuable tidal scour it formerly possessed, but that the narrowing of the channel by these embankments absolutely "stops" the tide, and prevents its flowing so high up the country as formerly. On the other hand, it is asserted that the embankments compensate for any abstraction by a prolongation of the tidal action upwards and its consequent acceleration. Some persons in the first category even say, that an assumed falling-off of the tide in the Pool, amounting to 7 inches, is attributable to the embankments.

The first question that arises is, have the tides at high water fallen off in the Pool? Undoubtedly the low water is considerably lower, but from tidal observations at the various docks it does not appear that there is any falling off at high water; and as regards the river above bridge within the influence of the Embankments, the tides undoubtedly attain a higher range than formerly during equinoctial spring tides. The best possible proof that the tides have not fallen off in the Pool is that the average high water for the year 1875 was 13 inches below Trinity standard, and this is precisely 6 inches higher than the average height as calculated in the Admiralty yearly tide-tables. From 1836 to 1842 the average height registered at the London Docks was 16 inches, or 3 inches lower than in 1875. The low water of 1873–75 was also 5 inches lower than the mean low water from 1833 to 1843, and the mean range increased by 7 inches.

(To be Continued.)

CORRESPONDENCE.

CORRECTION.

CINCINNATI, *September 12, 1877.*

Editor ENGINEERING NEWS.

SIR:—The channel span of the Ohio River bridge, Cincinnati Southern R. R., measures 519 feet between centres of piers, and 515 feet between centres of end pins. Its upper chord weighs 743,700 pounds, and is 157 feet above extreme low water. The above is in correction of the note contained in your issue of the 8th inst., stating the span to be 520 feet, the weight of the top chord 1300 tons and its height 185 feet above ordinary water.

C. L. STROBEL,
Ass. Eng. C. S. R. R.

BOOK NOTICES.

A PRACTICAL TREATISE ON WATER-SUPPLY ENGINEERING: relating to the Hydrology, Hydrodynamics, and Practical Construction of Waterworks in North America. With numerous Tables and Illustrations. By J. T. Fanning, C.E., Member of the American Society of Civil Engineers. New York: D. Van Nostrand, Publisher, 1877. Price $6.00.

In the preface to his treatise Mr. Fanning states that "at the close of the year 1875, fifty of the chief cities of the American Union had provided themselves with public water supplies at an aggregate cost of not less than ninety-five million dollars, and two hundred and fifty lesser cities and towns were also provided with liberal public water supplies at an aggregate cost of not less than fifty-five million dollars."

We have before us as we write a list of 443 cities and

towns in the United States and Canada which either have now, in operation or construction, works for a public water-supply for their inhabitants; during the visit of the Civil Engineers Society to New Orleans in May of this year, we learned from a leading Hydraulic Engineer who was present, that if he would but accept the terms of payment offered, he could find abundant employment for years to come in designing and constructing water-works in Southern cities; the gleanings from exchanges each week in this Journal give evidence of the constant and growing agitation on the subject of a public water supply by the rapidly growing cities and towns of the Northern States, and if our readers could but get into the confidence of the managers of the few large pipe foundries in the country, they would be surprised to learn the many new water-works projects that are being inaugurated.

A few years ago and the principal attention of Engineers, young and old, was turned towards railroad construction; that day has passed away, and in consequence of the popular demand for improved sanitary conditions, and the cheapness of labor and materials for effecting improvements, Engineers have naturally turned their thoughts to that branch of business where their services would be most in demand.

But to the young Engineer who proposes to make a specialty of water-works construction, a serious difficulty arises at the outset in the absence of any complete treatise on the subject from which he may gather such information, as, joined to his previously acquired theoretical and practical knowledge will enable him to make a tolerable complete survey of his chosen field of study. The literature of Water-supply Engineering, like that of many other branches of the profession, is obtainable only in numerous pamphlet reports, or individual works of great expense and frequent inaccessibility.

To supply the need of a comprehensive treatise on the subject of Water-supply Engineering is the aim of the present work, and in looking over its 610 pages of text, and 30 more of index, we can assure our readers that the compiler has certainly earned the tribute of their thanks, and the more encouraging one of their patronage, in bringing together in one volume so great a mass of information on a subject that is daily growing in importance to the profession and the general public. We quote from the Preface the following which is the best expression of the objects of the work that we can give:

Among the objects of the author in the compilation of the following pioneer treatise upon American Water-works are, to supply water-commissioners with a general review of the best methods practised in supplying towns and cities with water, and with facts and suggestions that will enable them to compare intelligently the merits and objectional features of the different potable water sources within their reach; to present to junior and assistant hydraulic engineers a condensed summary of these elementary theoretical principles and the involved formulas adapted to modern practice, which they will have frequently to apply, together with some useful practical observations; to construct and gather, for the convenience of the older busy practitioners, numerous tables and statistics that will facilitate their calculations, some of which would otherwise cost them, in the midst of pressing labors, as they did the author, a great deal of laborious research among rare and not easily procurable scientific treatises; and also to present to civil engineers generally a concise reference manual, relating to the hydrology hydrodynamics, and practical construction of the water-supply branch of their profession.

The work is too voluminous for us to enter into a critical examination of the accuracy of its statements or the genuine value of its contents. The reputation of the author must suffice for that. We give, however, a brief analysis of its table of contents. The work is divided into three sections, comprising twenty-four chapters. Section I. treats of the "Collection and Storage of Water, and its Impurities," and after the introductory chapter devotes eight more to the subjects of Quantity of Water Required; Rainfall; Flow of Streams; Storage and Evaporation of Water; Supplying Capacity of Water-Sheds, Springs and Wells; Impurities of Water; and Well, Spring, Lake and River Supplies. Sec. II. treats of the "Flow of Water through Sluices, Pipes and Channels," and devotes six chapters to the Weight, Pressure and Motion of Water; Flow of Water through Orifices; through short tubes; through pipes under pressure; Measuring Weirs and Weir gauging; and Flow of Water in Open Channels. Sec. III. is on the Practical Construction of Water-works, and ten chapters are given to Reservoir Embankments and Chambers; Open Canals; Waste Weirs; Partitions and Retaining Walls; Masonry Conduits; Mains and Distribution Pipes; Distribution Systems and Appendages; Clarification of Water, Pumping of Water; and Systems of Water Supply. These chapters are illustrated with wood-cuts and diagrams, and contain 116 Tables on a great variety of subjects connected with water works construction.

As a treatise for constant reference, and for genuine practical use by all who are interested in the subject of which it treats, it is incomparably the best in this country, and its cheapness will undoubtedly ensure it a place in the library of every engineer who wishes to keep "posted" in his profession.

That such a valuable book should be unexceptionable in typographical appearance, in the quality of its paper, and character of binding is to be supposed, and in all these particulars the publisher has succeeded most decidedly.

AN ELEMENTARY COURSE OF CIVIL ENGINEERING for the Use of Cadets of the United States Military Academy. By J. B. Wheeler, Professor of Civil and Military Engineering in the United States Military Academy at West Point, N. Y., and Brevet Colonel U. S. Army. New York: John Wiley & Sons. Chicago: Jansen, McClurg & Co. 1877. Price $4.00.

It may be presumed that all books treating of a subject of such magnitude and scope as that of Civil Engineering are compilations; for it would be difficult to conceive a writer capable of asserting himself *facile princeps* in the various sciences and varied knowledge comprised under that head. Assuming the presumption to be correct, we turn to consider what standard should be accepted to prove the value of such a book, and conclude that what is essentially necessary is, that all the information collated, should be gathered from the best authorities on the several branches of knowledge bounded by the limits of the object of the work.

The author of the book now before us, says in the preface that it is specially arranged for the use of the United States military cadets, to whom but little time is allowed for the study of civil engineering, and he also points to the authorities from whom he has collected his materials. Without this suggestive hint, we note that the work is generally arranged after the manner of the late Professor Mahan's "Civil Engineering," for throughout its pages we frequently discover unmistakable evidence that the latter popular book has been considerably drawn upon; but the matter has been condensed, and, to a large extent re-written, the better to comply with the author's purpose.

We would call attention to the valuable articles on limes, cements, concretes, etc., in the first portion of the book, on Building Materials, which are taken from the works of Gen. Q. A. Gillmore, and contain besides, original matter contributed from the latest experiences and experiments of that authority.

In Part II. we are given much data on the strength of materials, beams, etc., the information on which subjects, although necessarily of an elementary character, give proof of a standard value, from the authorities frequently quoted. Both on the above topics, and again on the subject of strains, the limits of the book has compelled a severe condensation; but this we are inclined to favor; for students, so long as the bare facts are retained and made attractive, tire of wading through so much reading to arrive at a conclusion, and, we think, prefer to hunt up authority themselves on any desired point.

The larger portion of the book is devoted to construction, examples of which are drawn from all points of the compass, and from the works of the best known constructive engineers. Construction must always remain the principal feature of engineering science. Towards constructive ability the acquisition of a thorough knowledge of the many topics touched upon in the first portions of this work lends its aid, while the accumulation of experience derived from actual engineering works helps to foster and improve new ideas; and while an "Elementary Course of Civil Engineering" have been specially arranged for the use of United States military cadets, we would recommend it to all young engineers, and for the matter of that, to older ones too, as containing much useful information, indeed, more than memory can be burdened with without such aid.

The book is well bound, contains 472 pages, is illustrated by 237 wood-cuts, and in general appearance does credit to all concerned in its production.

TABLES FOR THE DETERMINATION AND CLASSIFICATION OF MINERALS FOUND IN THE UNITED STATES. By James C. Foye, A. M., Professor of Chemistry and Physics, Lawrence University. Chicago: Jansen, McClurg & Co. Price 75 cents.

In the preface to the above little work, the author states his object in compiling it, to be to supply the student of mineralogy with tables, by which he may determine and classify the minerals found in the United States, and become familiar with their principal characteristics. The names given as authorities from which the compilation and collection of data have been taken sufficiently guarantee its general correctness, and the nomenclature and classification of Dana given in his fifth edition of mineralogy, justifies the belief that the author has contributed a handy little reference book for immediate use. In it we have first: Introduction—in a measure explaining the use of the tables, etc. Second: the Determination of minerals, being a series of tabulated tests; and third: Classification—to which is added an appendix.

PUBLICATIONS RECEIVED.

Elementary Discussion of the Principle of Least Squares. By Mansfield Merriman, Ph. D., Instructor in the Sheffield Scientific School, New Haven, Conn.

On Tunnel Construction. By Arthur Ernest Baldwin, A. K. C., Stud. Inst. C. E. Proceedings of the Institution of Civil Engineers, London.

Pamphlets on the Protection Policy. Published by the American Iron & Steel Association, Philadelphia, Pa.

Atlantic Monthy:—"Echoes from an Old Parsonage," in the October *Atlantic*, is by the author of the famous paper on "The Total Depravity of Inanimate Things," which appeared in the *Atlantic* a dozen years ago. The Old-Fashioned Ghost Stories," in the same number are by the author of "Life in the Backwoods of Canada" T. W. Higginson, Thos. Gould, the sculptor, Prof. Wm. Everett, Miss C. F. Woolson, H. E. Scudder, W. D. Howells, and others, are among the writers in the Contributors' Club and department of Recent Literature.

Harper's Monthly.—A glance at the index will sufficiently indicate the character of the number for October: Mytown—Rose Terry Cooke; Hunting the walrus—W. L. Alden; The life of a New York Fireman—William H. Rideing; Girl and woman—A poem—Fannie R. Robinson; The Campaign of Burgoyne—W. L. Stone; On a Melon Schooner—A Story—B. Phillips; A group of Classical Schools Part II.—Horace E. Scudder; Fabrics—A poem—Edgar Fawcett; From Brusa to Constantinople—S. G. W. Benjamin; An Old Umbrella—A poem—C. P. Cranch; The Home Concert—A poem—Mary D. Brine: Raspberry Island—A story—Constance F. Woolson; Popular Exposition of some Scientific Experiments, Part VII., Burning Glasses and Mirrors—Dr. John W. Draper; Erema; or, My Father's Sin—R. D. Blackmore; The Regular Army of the United States—General George B. M'Clellan; Editor's Easy Chair: Editor's Literary Record: Editor's Scientific Record: Editor's Historical Record: Editor's Drawer.

THE following are the additions to the membership of the American Society of Civil Engineers elected Sept., 5th 1877:

Members.—John B. Atkinson, Earlington, Ky.; Charles B. Brush, Hoboken, N. J.; George M. Frazel, Galveston Texas; Philip Golay, Cincinnati, O.; James A. Hayward, Galveston Texas; Thomas H. Johnson, Columbus, O.; H. W. Parkhurst, Louisiania, Mo.; Arthur Spielmann, Hoboken, N. J.; Clinton F. Stephens, Dallas, Texas;

Associate.—Alfred G. Compton, Professor of Mathematics, Astronomy and Engineering, College of City of New York, New York.

Junior.—William D. Bullock, Assistant City Engineer, Providence, R. I.

Mexico has about 350 miles of railroad, and wants more, but hasn't the money to build with.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

OBITUARY.

BREVET MAJOR ARTHUR H. BURNHAM, Captain of Engineers, U. S. A., died in Lowell, Mass., on the 12th inst., aged 36 years. During the late war he constructed the battery which permitted the passage of Farragut past Fort Morgan, for which he was publicly commended and promoted. Previous to September, 1872, he was the engineer in immediate charge of the Des Moines Rapids improvement, at Keokuk, Iowa, under Col. J. N. Macomb, but for the past few years had been assigned to duty at Boston. As an engineer he took a leading rank in his profession, and was possessed of intellectual abilities of a high order.

PERSONAL.

GEO. F. ROBINSON, C. E., of Loveland, Ohio, has been appointed Superintendent of the Waynesville, Port Huron & Washington C. H. narrow-gauge railroad.

At a meeting of the Board of Directors of the Pittsburgh, New Castle & Lake Erie R. R. Company, in Pittsburgh, on the 12th inst., D. F. Culver, Esq., resigned his position as President, to accept that of Consulting Engineer of the company. He will exercise general supervision over the construction of the new road.

BRIDGES.

Hamilton county, Iowa, has awarded the contract for an iron bridge across Boon river, at Webster City, to the Wrought Iron Bridge Company, of Canton, Ohio. The bridge is to be 150 feet in length and will be the first in Hamilton county. The cost will be about $4,000.

The Rockford (Ill.) *Weekly Gazette* says: "A new bridge is to be immediately built at Pecatonica, to take the place of the Truesdell fraud. It is expected to be of the King patent, and to cost $5,000, one half of which is paid by the county, and the remainder by the township of Pecatonica."

Work on the new bridge of the Lake Shore & Michigan Southern R. R. across the Maumee at Toledo is progressing favorably. One pier is nearly finished. Another is nearly up to the waters edge. The two others are being started. The building of all four will be completed in about two months. The bridge will be of iron and equipped with double steel tracks. When completed it will be one of the finest structures on the road. The work will be pushed rapidly forward and it is expected that the trains will be moving over it early in the spring.

Capt. James B. Eads publishes a card to correct the statement, which has recently been going the rounds of the press, that he is planning to build a bridge over the Bosphorus, in which he says: "When in Constantinople, three years ago, I was requested by the Grand Vizier to furnish the Ottoman government with plans and estimates of the cost of such a bridge. These were prepared and forwarded about two and a half years ago, but as a change of Ministers occurred soon after in that government, and the grant to improve the mouth of the Mississippi was passed by Congress, the subject has received no further attention from me."

From the Ottawa (Ont.) *Citizen* we learn that a meeting of gentlemen interested in the construction of the Inter-provincial bridge across the Ottawa river at Gatineau Point, was held in the adjoining town of New Edinburgh, on the 12th inst. The plans exhibited of the proposed bridge contemplate a structure of iron, with stone piers, to be sufficiently elevated above the river to allow the largest vessels plying on the Ottawa to pass under it. There are to be seven piers, the largest in the middle of the channel, seventy feet under the level of the river, and rising sixty feet above it. The estimated cost of a bridge with solid stone piers is $230,000, and of a bridge with crib foundations and stone superstructures for the piers, $166,000. Such a bridge would accommodate a street railroad, foot passengers and carriages. The opinion was expressed that bonuses could be obtained not only from the municipalities interested, but from the Government of the Dominion, Ontario and Quebec, and that any further amount required might be obtained by subscriptions to stock. A committee was appointed to further necessary preliminary matters looking to the immediate construction of the bridge.

GAS AND WATER-WORKS.

London, Eng., consumes 120,000,000 gallons of water daily.

The Hartford, Conn., people are moving again in reference to a greater supply of water.

Amherst, Nova Scotia, is considering the question of a water supply for the town from the adjacent hills.

The adoption of the Hudson river plan by the water commissioners of Troy, N. Y., meets with general disapproval.

In a sudden freak, of what it calls economy, the city of Leavenworth, Kan., has decided not to light the street lamps.

The use of artesian wells to procure an efficient water supply for Waterloo, Iowa, is being advocated in that city.

After an expenditure of $15,862 on 889 meters in Toronto Ont., the water commissioners of that city find them all but useless.

The new water mains which have just been put in, at an expense of $12,000, in Allegheny, Pa., have fully alleviated the former scarcity of water in that city.

A leading gaslight company of New York has reduced the price of gas twenty-five cents. The officials say the reduction is made on account of the growing use of kerosene.

The Perth, Ont., town council, at their meeting on the 10th inst., appointed a committee to collect information regarding the probable cost of water works for that town.

The city council of Hamilton, Ohio, have awarded the contract for furnishing that city with gas, for a period of ten years, from June 3d 1878, to the Citizens Gas Light Co., of Hamilton.

At a meeting of the Hyde Park, Ill., Board of Trustees, on the 17th inst. a resolution was offered and referred dissolving the partnership between the towns of Lake and Hyde Park in the matter of water works.

The daily average consumption of water at Saratoga Springs, N.Y., during the month of August was 1,500,000 gallons. There were 5,000,000 gallons less of water pumped at the public water works during that month, than during the corresponding month of 1876.

According to the Indianapolis *Journal*, the water from the well furnishing the supply to Marion, Ind., must be possessed of medicinal virtues of a high character. It is stated that "many people from the country use the water as a preventive for ague and biliousness, and carry it home by the barrel."

The Cornish engine which drives the Providence, R. I., water works, about which there have been very damaging rumors, has been repaired and set in operation again at an expense of only $400. It is said there is a ring in the city government which spreads the stories of the inefficiency of the water works machinery.

The new Indianapolis gas company are pushing the work of laying their mains with considerable vigor, and propose to be furnishing gas within sixty days. The residents of that city will probably receive a considerable degree of benefit from the competition resulting between this, and the old company, as it is stated that the latter propose to reduce the price of gas below that fixed by the new company, whatever it may be.

From the Brooklyn (N. Y.) *Union-Argus* we learn that the water supply system from the Prospect Park Reservoir to Coney Island has been tested and fully meets the expectations of Engineer Culyer, its projector. The water has a natural head or force sufficent to reach the top floors of any of the hotels on the Island. By next summer the pipes will be laid if the demand requires it, the entire length of the Island.

The Board of Water Commissioners of Jacksonville Ill., have addressed the city council, recommending and urging that the council at once make an appropriation sufficient to complete and strengthen the flood-gap at the impounding reservoir by massive stone and brick work, such as is demanded in order to safely restrain and impound the vast body of water (60,000,000 gallons). The flood-gap was never wholly completed, purposely that experience and prolonged test might prove just what is best to be done. The appropriation asked for by the Commissioners was granted by the council.

The Laporte (Ind.) *Herald* in an editorial upon the water supply of that city, says: "Our citizens pay a good, round, general tax for water supply, and a fair water rate for the privilege of its use; but the money now paid for it, except for fire protection, is nearly thrown away, it being wholly unfit for drinking or culinary purposes, and nearly so for washing, and poor as its quality is, even that is in a fair way to fail. The question is forced on the city, how to obtain an unfailing supply of passing quality, and immediate action of some kind is imperative. The council should not shrink from such expense as is necessary, nor should any one grumble or find fault with what cannot be avoided."

At a meeting of the city council of Sterling, Ill., on the 3d inst., the committee to whom, at a previous meeting, the proposition of Messrs. P. B. Perkins, S. C. Harvey and others, as a private company, to construct water works for that city, had been referred, made a report in favor thereof, which was unanimously adopted, and the city attorney was instructed to draw an ordinance covering a contract with Messrs. Perkins, Harvey, and their associates for the construction of the works. The proposition of the parties named, provides for the laying of four miles of distributing pipe, of the sizes of four, five, six and eight inches, and not less than twenty-five hydrants; also for the construction of a reservoir or pumping-well of not less than 250,000 gallons capacity, and pumping machinery with a capacity of 1000 gallons per minute; the entire works to be completed within ninety days from the passage of the ordinance referred to.

RAILROADS.

Davenport, Iowa, is to have a new street car line.

It is said that New York street railroads carried 165,000,000 passengers last year.

J. M. Jones & Co., of West Troy, N. Y., are building ten cars for a Bombay street railway company.

The Cream City Street Railway Co., of Milwaukee, received their Baldwin steam car on the 16th inst.

There is a prospect that work will shortly be resumed on the Burlington, Monmouth & Illinois River R. R.

At Peoria, Ill., they are talking up the project of building a narrow-gauge railroad from that city westward.

The survey of the Whitehaven Ry. in Cape Breton, is to be proceeded with in October next, and the work begun in 1878.

Thirty miles of the Fon du Lac, Amboy & Peoria narrow-gauge railway, have been built this year, south from Bond du Lac, Wis.

"Some wealthy gentleman of this vicinity and New York," says the Troy (N. Y.) *Times*, "are considering a narrow-gauge R. R. between Albany and Troy and Saratoga Springs. Estimates of the cost and of the probable receipts of such a line are now being made, and if it be determined that the road will pay expenses, it will be constructed. The route will be over the shortest practicable line, running direct from Mechanicsville to Saratoga, and thence possibly to Saratoga lake. We should not be surprised to see the road built at an early date."

The directors of the Pittsburgh, New Castle, & Lake Erie (narrow gauge) R. R. held a meeting in Pittsburg, on the 12 inst., to consider the bids for the construction of the first thirty miles of their road from Pittsburgh, to Harmony. Eighty-five bids in all were received, the lowest being that of V. L. Larry, of New York, whose offer was to build the length referred to, for $255,990; being about $1,500 per mile less than what the company had estimated the expense would be. The contract specifies that the road be completed to Harmony in eight months from the date of award. There will be three tunnels on the road—aggregate length, 1,000 feet—and fifteen bridges, 1,200 feet in length. About a thousand men will find employment for eight months, when work on the line commences.

The citizens of Ann Arbor, Mich., have subscribed $21,050 for the Toledo and Ann Arbor R.R. The sum desired is $25,000.

A narrow-gauge railroad is projected from Cleveland, Ohio, or Fostoria to Van Wert, and thence westward on the old Toledo & St. Louis route.

The report on railways in India, for the year 1876–77, furnishedto the government there, shows that there are now open 6,937 miles, of which 479 miles were completed in 1876.

The Secretary of War has formally decided that the railway companies are entitled to pay for transporting troops to threatened points along their own lines during the late striking disturbances.

The Grand Trunk Ry., of Canada, proposes to introduce steel cars for the carriage of grain. They are to be shorter than the standard wooden cars, but will carry a weight of eighteen, instead of ten, tons.

Indiana has 3,986 miles of railroad and 553 of side track, the total assessed value of which is over $39,500,000. There are only six counties in the State that have no railroads passing through them.

Articles of association for the extension of the Utica & Black River R. R., from Morristown to Ogdensburg, have been filed with the Secretary of State of New York. Work on the extension will be commenced immediately.

The Erie Railway Company now disposes of all its old worn out rails to different mills, and purchases all its steel rails instead of manufacturing. Steel rails at $45 a ton are considerably less per ton than the iron rails formerly cost.

A meeting of directors of the Coteau Landing R. R. Company took place at Lancaster, Ont., on the 4th inst., when it was decided to enter into negotiations with certain capitalists to secure the speedy construction of the road.

Mexico contains only one railroad of any length, and that runs from Vera Cruz to the city of Mexico, 292 miles with a branch to Pueblo and another branch to Jalapa, 61 miles. All the other roads aggregate less than 50 miles. The principal company is English, with its head office in London. Its road cost $37,700,000.

The contract for building that portion of the Danville, Olney & Ohio River R. R., lying between Danville and Olney, Ill., being one hundred miles in length, was let on the 10th inst. to Col. L. N. Yeoman, L. B. Jones and S. F. Rock, of Washington C. H., Ohio. This road is to be a three ft. gauge, and is to be completed on or before October 1st, 1878.

The Lake Shore Foundry, Cleveland, has made a cast iron pipe with six foot aperture, to be used for a culvert. The iron is 1 3-8 inch thick, which makes the pipe capable of sustaining great pressure. A Michigan railroad has ordered them, and if they work well it is anticipated they will supersede the common stone culvert. Each one weighs 3 tons.

A number of Boston capitalists, interested in the proposed Boston, Albany & Schenectady R. R., made an examination of the several routes proposed from Schenectady to the Hoosac Tunnel last week. The length of the proposed road would be about 48 miles, and its construction would, it is considered inure greatly to the commercial interests of both Boston and Albany.

English capitalists have agreed with A. B. Stone, Esq., to furnish $800,000 as a basis for the consolidation and completion of the Ohio Valley R. R., in connection with the Marietta road. This was made contingent upon the consent of the German stockholders, whom Mr. Cyrus Field will communicate with. The English stockholders appointed an agent to examine the condition of the Valley Road, and he will commence work in a few weeks.

MINING.

The monthly shipments of gold and silver from Arizona amount to $270,000, or at the rate of about $3,250,000 for twelve months.

According to the Atlanta, *Constitution*, from $30,000 to $50,000 a month reaches Atlanta from the gold fields of Northern Georgia. The silver mines are also very profitable.

The lead interest of Galena, Illinois, has been very seriously injured of late years by the superabundance of lead produced in the reduction of Nevada and Colorado silver ores.

It has been proved in Nevada and other silver-producing states of the West that capital devoted to agriculture pays better and more regularly than if put into gold and silver mines.

The Charlotte (N. C.) *Observer* says a rich pocket of gold ore has been discovered near that city. The first bucketful taken out is one half gold, and in the ore are strata of pure gold the size of a man's finger.

The metal, columbian, which was discovered some fifty years ago, and which resembles nickel, in its properties, but is more like tin in color, is now talked of as a substitute for both of these metals, in the plating process. It has been very scarce, but deposits of it have recently been discovered in North Carolina and in Colorado.

The Michigan salt product for the month of August, according to the State Salt Inspector's returns, was 193,280 barrels, against 183,897 during the same month in 1876. The amount manufactured this season to date is over 100,000 barrels in excess of last season, the shipments aggregating over 800,000 barrels, the larger portion of which was sent to Chicago.

There is every reason to believe that the cinnabar deposits of California are inexhaustible. The new Almaden mines which are still worked, are at present the chief source of supply. Last year the yield of quicksilver in the State was over 75,000 flasks. Since 1850 the total product has been some 860,000 flasks, representing a value of $50,000,000. For the last twenty-five years the total exports of quicksilver have been over 600,000 flasks, and the export is yearly increasing. China is California's best customer for the liquid metal. Within the past two years and a half nearly 62,000 flasks have been shipped to Hong Kong.

SCIENTIFIC.

Mr. C. Lauth has found that the hydro-sulphuric putrefaction of sewage may be prevented by simple æration.

A writer in *Cornhill Magazine* says that the amount of heat required to vaporize a quantity of water which would cover an area of 100 square miles to a depth of 1 inch, would be equal to the heat which would be produced by the combustion of half a million tons of coal, and that the amount of energy of which this consumption of heat would be the equivalent corresponds to that which would be required to raise a weight of upward of 1000 millions tons 1 mile high. To evaporate the annual rainfall on New York State alone in a year would require about five times the annual coal out-put of the United States.

"Far from being a source of danger," says the *Telegraphic Journal*, "the electric telegraph must be regarded rather as a cause of safety, as a net-work of lines spread over the country tends to prevent an accumulation of electricity at any particular point, by continually and silently discharging it to the earth. This is particularly the case in districts where every pole has an earth wire to it, running from the top to the bottom. That these wires effectually discharge a lightning-flash has been seen in cases where the wires have been terminated within a few inches in the top of the pole; a lightning flash striking one of these destroyed the portion of pole above the wire, but at the point where the wire commenced all damage ceased."

MISCELLANEOUS.

Cleopatra's Needle will arrive in England the middle of November.

A glass roof, six hundred by four hundred feet, supported on an iron frame work, is to be erected over the platform at the new Union depot in Pittsburgh, Pa.

The Albany, N. Y., police board has adopted the telephone for telegraphic purposes between the police stations, etc. The introduction will cost $900.

The deposits in the great marshes at Montezuma, N. Y., have been found to be very valuable as fertilizers, and capitalists are shipping them away.

New York State has abandoned the manufacture of lime at Sing Sing, and the works have been rented, the state receiving a royalty on each barrel of lime made.

The dome of the new Cook County court house, and city hall in this city, will it is said be second in height only, to that of St. Peter's at Rome.

The engineers of Marseilles have, it is said, discovered that, since the opening of the Suez Canal, the level of the Mediterranean has sunk three and one quarter inches.

Savannah, Georgia, warned by the terrible epidemic of last year that swept away so many of its citizens, has spent nearly $9,000 in sewerage. This year the city has been spared, and the people regard the money as not only well spent, but are willing to put more after it.

The Amazon river rises in the mountains of Quito and runs 3,400 miles before it discharges itself by ten channels, into the Atlantic. Orelhan, a Spaniard, sailed its whole course in 1541. When joined by the Apurimac it is 150 miles wide and is 40 fathoms deep, 1,500 miles from the sea.

M. Krantz, the Commissioner General for the Paris Exhibition, has addressed a letter to the foreign representatives, announcing that the principal parts of the Exhibition building will be finished on the 15th of September. Architects and engineers of the foreign commissions will then be admitted to commence work on the sides allotted to them.

It is reported that the Eddystone Lighthouse, built by Smeaton, on the celebrated rock of that name in Plymouth Sound, is to be taken down, not because of any instability in the building, but of the weakening of the rock itself under the action of the sea. It is proposed to re-erect this model lighthouse on the mainland, that its materials, at least, may be preserved in their original form. It is the third structure on that rock, and was erected in 1756-59

Roraima is a great table mountain on the borders of British Guiana, whose steep and inaccessible sides rise from the height of 5000 feet above the level of the sea, 20,000 feet sheer into the sapphire tropical sky. This wonderful place is in other respects a marvel of the world. The highest waterfall known tumbles from its summit at one leap of 2000 feet, and then rushes impetuously 3000 feet more on a slope of forty-five degrees down to the bottom of the valley, broad enough to be seen thirty miles away.

The New York canals, during August, earned $137,956 tolls, $38,959 less than during August last vear. For the eight months of 1877 that have passed, the total tolls have been $442,904, a decline of $295,780 compared with the corresponding period last year. This income is barely one-third the amount necessary to sustain the canals, as required by the State constitution. All the lateral canals are to be sold to relieve the Erie Canal from the burden of sustaining them, and the canal board then hope to render the Erie Canal "once more a paying concern."

The St. Louis Board of Trade, at a recent meeting, decided to appoint a committee to visit New Orleans during the present month and examine the scheme submitted to them by Capt. John Cowden to connect the Mississippi river snd the deep waters of the Gulf of Mexico by a canal, starting opposite the city of New Orleans, and reaching the gulf at the Barataria Bay, a distance of fifty-five miles. There is already a water communication along the line, and a steamer makes semi-weekly trips from the Mississippi to the bay. The Barataria Canal Company has been incorporated by the State of Louisiana, and surveys have been made showing the practicability of the scheme.

Scientific opinion in France is by no means unanimous as to the desirability of creating an inland sea in Algeria. M. Naudin read a paper on the subject at the last meeting of the Academy of Sciences, in which he said its sanitary effects would be deplorable. He asserts that to fill the basin with salt water would be equivalent to reproducing in Algeria all the worst features of the Pontine marshes. Capt. Roudaire admits that even in the centre there would not be more than eighty feet of water, and the whole coast line would have so little water that it would be little better than a sand bank, with an admixture of salt and fresh water, upon which the strong solar light and tropical heat would act in the most deleterious manner for two-thirds of the year, causing a rapid decomposition of organic matter, and spreading contagion for miles in every direction.

SANITARY REFORM AND THE CIVIL ENGINEER.

An association, representing what may safely be called the most progressive class of the world's busy workers, is this week holding its session in this city for the transaction of business, and on the discussion of subjects which directly affect the physical and material welfare of every civilized community.

To the intelligent and untiring investigations into the causes of disease, their prevention and cure, and the collection of vital statistics by these diligent students of a most noble science, are we indebted for a greater portion of our commercial prosperity than at first thought will be acknowledged by the business men of the world. Disease, in one form or another, is always at work on the human family, decimating its ranks, paralyzing the bodies and minds of its members, and laying the burden of an enormous taxation upon the whole community. In the tendency of people to congregate in large cities and towns lie the evils of overcrowding with all its direful consequences, and it is against these that the science of medicine has to wage unceasing battle.

The list of subjects to be presented at the meetings this week will reveal their very practical character and is a good index of the kind of labors and investigations in which the members of the American Public Health Association are engaged.

To the readers of this journal, however, one feature must be most prominent--the intimate relations which exist between public health and the works of the civil engineer. Two of the divisions of subjects by the Association relate to sewerage and drainage and the great evils resulting directly from the want of such sanitary works, and in the diffusion of a wider knowledge of these subjects the civil engineer and the physician are co-laborers; the latter is the collector of the statistics from which by study certain facts are deduced in relation to disease and its causes, and it is he that must point out to the public the measures to be adopted to alleviate these ills and convince it of the necessity of proper sanitary regulations; the engineer is the one to carry out these ideas, and by his skill and intelligence construct the necessary works for the proper drainage, sewerage and ventilation of our streets, houses, and public buildings.

The Executive Committee of the American Public Health Association has recommended, that, for their meetings, the leading discourses, papers and discussions shall be arranged under the following Divisions of Subjects:

I. Sanitary Topography and the Systematic Drainage and Sewerage of Cities and Villages.—Other Problems of Public Health.

II. Sanitary Control and Extermination of the Contagia of Typhoid (Enteric) Fever, Scarlatina, Small-Pox, etc.—Other Problems of Domestic Health.

III. Expert Testimony and the Pursuit of Exact Scientific Researches in Public Health Service.

Under these three general divisions, contributions will be offered upon the topics named in the annexed schedule.

1. Discourse, by the President of the Association, on the Sanitary Topography of Chicago, and the Artificial Remedies of Natural Disadvantages. 2. Report on the Proposed Sanitary Survey of the United States. 3. A Paper on Problems old and new in the Sanitary Drainage and Sewerage of Chicago and other Western Cities. 4. A Discourse on the Sanitary Geography of Phthisis Pulmonalis and other Pulmonary Diseases. 5. A Report of the experience of the Department of Physical Education and Hygiene in Amherst College. 6. A Discourse on the relations of Hygiene to higher Education. 7. A Paper on "Stamping Out" Scarlatina and the Extinguishing of Zymotic Disease. 8. A Paper on the Sanitary and Economical value of Forests. 9. A Review of the teachings of 22 years' records of Mortality from Croup, Diphtheria and Scarlatina in a New England city. 10. A Paper on Removal and Utilization of Domestic Excreta; and a discussion on the Miasmata of Dwellings and Dwelling-grounds. 11. A Paper on Sanitation of Individuals in preventing Disease. 12. A Paper and Discussion on Pollution of Streams. 13. Report on a Practicable method for securing Complete and Authentic Records of the Causes of Death throughout the United States. 14. Suggestions respecting the Sources and Propagation of Trichina, considered with reference to Sanitary Measures. 15. Suggestions for the better Hygienic Care of Sailors and other Watermen. 16. Sanitary Safety in Railway Travelling.—Facts in the interest of Travellers and of Carriers.

17. A Paper on the means for diminishing Infant Mortality from Bowels Affections. 18. A Paper on Garden City. 19. Statement and Discussion on the Sanitary and Economical Importance of the best Surgical and Medical Treatment of the Needy Poor. 20. A Paper on the Tests and Supervision of Milk-supplies of Large Cities. 21. A Paper on Hygiene in the Prevention of Insanity. 22. Report on Enteric (Typhoid) Fever as observed in Vermont. 23. Preliminary Outlines of the new Points of Enumeration and Inquiry which the Interests of the Public Health require in the Tenth National Census. 24. Report on Available Methods of Promulgating Sanitary Knowledge and Authorized Information in regard to Vital Statistics and Prevalent Diseases. 25. Discourse on the Judicial and other Aids of Law in Public Health Service.—A Practical view of the subject. 26. Discourse on the Present State of Exact Knowledge of the Causation and Prevention of Epidemic Diseases.

LAND SURVEYING IN THE DOMINION.

BY P. L. S.

VIII.

(*Concluded from page 256.*)

19. Before any person is admitted to practice as a Land Surveyor in Upper Canada, or for Lower Canada, he shall be publicly examined with respect to his ability, and the sufficiency of his instruments, by one of the said Boards of Examiners, as the case may be, and moreover the further to promote the collection of geological information, all persons who apply to be admitted as Provincial Land Surveyors, shall be examined in the rudiments of Geology; and the Director of the Geological Survey shall, with that object, be a member of both the Boards of Examiners.

20. The said Examiners shall cause all persons applying for admission to practice as such Land Surveyors, to produce satisfactory Certificates as to character for probity and sobriety, and to perform such practical operations in their presence as they may require, previous to their giving him their Certificate, and to answer such questions on oath, (which oath any one of the Examiners may administer) with regard to the actual practice of such applicant in the field and with regard to his instruments.

21. If the said Examiners are satisfied of his ability as hereinbefore provided, and of his having complied with all the requirements of this Act, and of the sufficiency of his surveying instruments, they shall give him a Certificate thereof, and of his being admitted as a Land Surveyor, in the form following:

This is to certify to all whom it may concern, that A. B., of in the County (or District) of hath duly passed his Examination before the Board of Examiners and hath been found qualified to fill the office and perform the duties of a Provincial Land Surveyor in and for Upper (*or* Lower) Canada, he having complied with all the requirements of the Law in that behalf. Wherefore the said A. B., is admitted to the said Office, and is by Law authorized to practice as a Land Surveyor in Upper (*or* Lower) Canada.

In witness whereof, We have signed this Certificate at in the County (*or* District) of Province of Canada, the day of one thousand eight hundred and

Signature of the President, C. D.,
Signature of the Secretary, E. F.

And such certificate shall; on his complying with the other requirements of this Act, enable him to practice as a Land Surveyor in and for Upper Canada or in and for Lower Canada, as the case may be.

22. Each applicant, after receiving the above mentioned Certificate, shall, with two sufficient sureties to the satisfaction of the said Board of Examiners, enter into a bond jointly and severally in the sum of one thousand dollars, to Her Majesty, Her Heirs and Successors, conditioned for the due and faithful performance of the duties of his office, and shall take and subscribe the oath of allegiance, and the following oath, before the Board of Examiners who are hereby empowered to administer the same:

"I, A. B. do solemnly swear (*or* affirm, *as the case "may be*) that I will faithfully discharge the duties of a "Land Surveyor, agreeably to law, without favor, affec-"tion or partiality. So help me God."

23. The said oath of allegiance and of office, shall, if taken in Lower Canada, be deposited in the office of the Prothonotary of the Superior Court in the District of Quebec; and if taken in Upper Canada, in the Registry Office in the County of York.

24. The said bond shall be deposited and kept in the manner by law prescribed with regard to the bonds given for like purposes by other public officers, and shall enure to the benefit of any party sustaining damage by breach of the condition thereof; and the certificate shall be registered in the office of the Registrar of the Province.

25. The Board of Examiners may in their discretion suspend or dismiss from the practice of his profession, any Land Surveyor whom they may find guilty of gross negligence or corruption in the execution of the duties of his office; but the Board shall not suspend or dismiss such Land Surveyor, without having previously summoned him to appear in order to be heard on his defence, nor without having heard the evidence, offered either in support of the complaint or in behalf of the Surveyor inculpated.

"Sufficiency of instruments" means that a student must possess a Gunther's chain and a theodolite, or a transit theodolite; an engineer's transit will do if an arc for measuring altitudes is attached, and if it is not the student will not pass, although it is well known that not one surveyor in one hundred in the whole course of his practice has occasion to determine a latitude or measure an altitude. But for the want of this arc attachment one applicant, a student in the office of a leading engineer in Toronto, was not allowed his diploma until he incurred the necessary expense of having the attachment placed on his transit.

The "examination in Geology" consisted in listening to a very interesting lecture by the justly celebrated Prof. Chapman, of Toronto University, and was a very pleasant episode in the students' experience.

"Certificates as to character for probity and sobriety." These were not demanded, as it is generally allowed that "there is cheating in every trade but the surveyor's," and as for the latter qualification—the honorable gentlemen of the Board knew how it was themselves.

"You may throw up your caps, gentlemen, for you are all passed," was Secretary Unwin's cheerful greeting for us on the thirteenth day of our visit at the Board rooms. We then took the oath of allegiance; paid twenty dollars for our certificate; paid two dollars more for a pine stick about four feet long, to be used in testing our chains; received a copy of the Surveyor's Act; were instructed as to the requirements of our bonds, which had to be sent in previous to our receiving our parchment, boxed up our transit theodolite, bade the gentlemanly Secretary good-bye, and, after settling our other expenses, went home with the conviction that the Board of Examiners of Ontario was a good deal of a humbug, an opinion which we see no reason as yet to change.

The gentlemen of that Board *know* that it is a humbug of the most fraudulent kind to require three years of a man's time to fit him to practice common land surveying; they *know* that passing their examination is not significant of a surveyor's actual abilities, and they *know* that upon the most despicable little quibbles, men older in the service than they are, and with whom, so far as actual knowledge of land surveying in all its details are concerned, they themselves cannot take equal rank, are rejected every year. Just think of requiring Thomas C. Keefer, Walter Shanley, or engineers of similar standing and intelligence, to apprentice themselves to a Land Surveyor for even *one* year, and oblige them to live with their master, or in his close vicinity, so as to attend him in all his practice, and then to go to Toronto or Quebec, and sit down and cipher out areas of many-sided fields, and answer as to their mathematical attainments before such men as compose these Boards. Imagine F. F. Passmore, P. L. S., questioning the President of the Institution of Civil Engineers, as to his knowledge of land surveying and the adjustments of a theodolite, and sending him back to serve his twelve actual months with a duly authorized P. L. S. And yet men who had had more practice in Canadian Land Surveying than Passmore has, and who, for all the ordinary business of a Surveyor or Civil Engineer, were equally as well qualified as the aforesaid President, have been refused admission to examination before this august Board on just these grounds. The gentlemen of the Board may say once for all that their duty is to comply with the plain requirements of the Act, and that they have no right or power to do otherwise. If they had any disposition to improve the status of the Provincial Land Surveyor, they could easily find the means of doing it. Upon their recommendation the Act relating to surveys and surveyors would be amended so as to allow civil engineers of undoubted intelligence and ability to be admitted to practice land surveying if they so desired, and by making actual knowledge of practical surveying the test, instead of the ability to figure out the routine problems which are set before students, a better class of men could be induced to enter the ranks than are now in it. We think an examination is a good thing, but we protest against the apprenticeship. It is simply no business of the examiner's how or where the applicant obtains his knowledge; if he can show to their satisfaction that he is qualified to make surveys, and can give the required bonds to protect his clients, he is entitled to a diploma. A Board of Examiners consisting of three men, who were well known as thoroughly qualified Land Surveyors, could take a party of young men (each examiner taking a third of the class) into the field, and in two or three days' time they could decide upon the qualifications of every student in field practice, and at the same time test their mathematical attainments, and their familiarity with the legal points involved. A surveyor's examination should be in the field where he expects to practice, and not in a class-room dozing over problems from Gillespie or Euclid. Responsibility is what makes a man, and apprentices do not have any responsibility. One single survey after the diploma has been obtained is worth more than a dozen previously, and if a young

man understands that he is liable to be mulched in damages for possible errors, he will naturally be on the alert to guard against mistakes, a feeling which as a student he would not possess.

LIVERPOOL ENGINEERING SOCIETY.

Last night (Sept. 12) this Society resumed its fortnightly meetings after the summer recess at the Royal Institution, Colquit street, Mr. C. Graham Smith, Assoc. Inst. C. E., President in the chair. The Hon. Secretary Mr. Wilkinson Squire, exhibited two specimens of old mortar. The first was from Sandown Castle, Kent, now in course of demolition by the encroaching sea. When tested it bore 472 lbs. dead weight on a section 1.8 inch area, or 263 lbs. per square inch. The second was recently brought by a member, Mr. Alfred Holt, M. I. C. E., from Nicopolis, a city built by Octavianus to commemorate his victory over Anthony Cleopatra, B. C. 31. Although it has not been tested it was evidently of remarkable hardness. The chief business of the evening was the reading and discussion of a paper by Mr. R. F. Pitt, Stud. Inst. C. E. on Engineering Labor—Piecework v. Daywork. Mr. Pitt endeavored to show that Piecework as contrasted with Daywork was greatly to the advantage of both masters and men. The latter earning much more money per diem and the former getting a greater amount of work performed. The labor question was governed by the laws of supply and demand. Such trades as those of masons, quarrymen and navvies should be paid by the piece. Mr. Pitt illustrated his paper with carefully prepared tables showing the advance in wages for various kinds of labor during the present century.

W. WILKINSON SQUIRE, *Hon. Sec.*

PUBLIC HEALTH ASSOCIATION.

The first session of the Fifth Annual Meeting of the Public Health Association, met in the parlor of the Grand Pacific Hotel, Chicago, at 2 p. m., Sept. 25. President J. H. Rauch, M. D., in the chair. There were present the following members: Dr. George L. Andrews, of Indiana; Dr. J. T. Reeve, Secretary of the Sanitary Board of Health, Wisconsin; Dr. Carney, Health-Officer of Cincinnati; Dr. Charles H. Folsom, Secretary State Board of Health, Boston; Dr. Chambers, of the Illinois State Board of Health; Dr. Elisha Harris, New York; Dr. Kempster, of Wisconsin; Drs. Lyman, Hamill, and Hosmer A. Johnson, of Chicago; the Hon. Wirt Dexter, the Hon. N. K. Fairbank, Dr. Lyon, Dr. Curtis Fenn, Dr. Starkweather, Dr. John Rauch, E. S. Chesbrough, City Engineer; Dr. Gregory, President Illinois Industrial University; Dr. John Reid, Chicago; Dr. H. B. Baker, Secretary State Board of Health, Michigan; Dr. Chancellor, Secretary State Board of Health, of Baltimore; Dr. Myers, Fort Wayne, Ind.; Dr. Gibson and Dr. Turner, Medical Inspector United States Navy; Dr. Hitchcock, State Board of Health, Michigan; Dr. Hewitt, Secretary Minnesota State Board of Health,; Dr. Azel Ames, Massachusetts; Dr. Cohen, Quincy, Illinois; Dr. W. M. Chambers, Charleston, Ill.; Dr. N. S. Davis and Dr. Brock McVickar, Chicago; Dr. Foote, of Galesburg; Prof. Churchill, of Galesburg; Dr. Steman, of Fort Wayne; Dr. Norman Bridge, Chicago, and others.

After an address of welcome by Wirt Dexter, Esq., the address of the President was read, after which, the secretary read his report. E. S. Chesbrough read a paper on the Sanitary Drainage and Sewerage of Chicago. How our Sewerage System has improved the health of the city was set forth, and then a detailed history was given of the efforts made in the direction of the improvement of the drainage system. The lecture was a supplementary history, with notes and comments, and map illustrations to that given by Dr. Rauch. Most of it was new to the strangers, and most of it was familiar to all who have perused the annual reports of the Board of Public Works. Mr. Chesbrough came to the conclusion, as to the final disposal of our Sewerage System, that it must pass through the canal, the South Branch may become again as offensive as in years gone by, and his proposal was to widen and deepen the canal.

Dr. Folsom, of Boston, followed Mr. Chesbrough in a discussion of the sewage system, and read a draft of laws which he had prepared in order that the Association might offer critical comments upon them before their being submitted to a Massachusetts Legislature. They were prepared by the State Board of Health, and are directed mainly against the pollution of streams and water-courses in the interest of sanitary improvement.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH,

President of the Liverpool Engineering Society; Associate of the Institution of Civil Engineers.

In treating this subject it is not here proposed to consider the abstract questions involved in the various methods of arriving at the theoretical strains on the different portions of girder work. It is nevertheless advisable to occupy some time in reviewing the practical details and circumstances which much modify not only these theoretical strains, but also the usual hypotheses on which their calculation is based. In this way it will be found that something more is necessary than a knowledge of the practical application of the principle of the lever and the triangle and polygon of forces in order to design successfully wrought iron girder work.

One of the first and principal requirements necessary in designing complicated iron work is to have a proper sense of the limits of application to assign to theoretical deductions. Having given the outline of a wrought iron structure, and the loads to which it is to be subjected, it only requires care and a patient study of existing structures and standard works in order to arrive at figures representing the strain on the various members of the structure, which would be accepted as theoretically correct by a majority of engineers. The aim in all designs ought therefore to be so to arrange the parts that there may be as little departure from theory as practicable; at the same time an engineer must not too readily accept the fascinating theories of uniform stress, or allow himself to be deluded into imagining that by any arrangement he can obtain a perfectly uniform strain throughout an iron structure.

The first hypothesis on which strains are usually calculated is that each member has a normal length whatever the strain put upon it, and that the strains on it are the same as they would be were it free to turn in a plane about its extremities. This practically amounts to considering each junction to be made an absolutely frictionless pin joint, and the material employed to be of precisely the same texture throughout the structure and perfectly rigid. How does the ordinary roof principle back comply with this assumption? Instead of having a frictionless pin joint at each intersection of a strut, it is more often made continuous, and frequently of sufficient strength to stand with half the trussing employed, as the strains in the ties and struts are modified and reduced by the resistance of the principle back to deflection. The connections in English designed girder work, instead of being frictionless pins, are generally comparatively rigid and made with innumerable small rivets. This system has many well known advantages which cannot now be gone into. The arguments for and against pin and rivetted joints would occupy the best part of an evening.

The Americans have developed the pin connection to a very large extent, and there can be no question but that with pins and eyes properly proportioned, simple systems (consequently few parts), and accurate workmanship, that theory may be more closely approached than with our complicated compound lattice girders, with rivetted joints.

Our transatlantic brothers seem to have been long aware that a certain amount of material put into one member will do very much more work than the same amount of material distributed over two or more members, and they are justly proud of their scientifically arranged bridges, which in point of economy and strength will compare more than favorably with our home productions.

Of all things tending to invalidate theoretical calculations the sun is about the worst. Mr. Clark says when speaking of the Britannia Tubular Bridge, "Although the tubes offer so effectual a resistance to deflection by heavy weights and gales of wind, they are nevertheless extremely sensitive to changes of temperature, so much so that half an hour's sunshine has a much greater effect than is produced by the heaviest trains or most violent storm. They are in fact in a state of perpetual motion, and after three months' close observation, during which their motions were recorded by a self-registering instrument, were never observed to remain at rest for a single hour." The same may also be said of the large bridges over our dock passages. The sun heats the top flange, whilst the wind, after sweeping along the water, impinges on the bottom flange, cooling it and causing it to contract, whilst the top flange is being expanded by the sun, thus putting a camber on the bridge much exceeding the deflection caused by the heaviest working load. This is the reason why most of the top flanges of the bridges on the Mersey Dock estate are painted white.

Many other practical examples might be given to show that if iron is prevented from expanding, the elasticity of the material must take up the would-be expansion; and consequently a greater or less strain is put upon the iron, according to whether the change of temperature acts in conjunction or contrary to the original strain in it.

It may be well now to investigate what strains may be thrown upon iron work by the ordinary changes of temperature in this country. If the difference between the extremes of temperature be assumed at 82° Fahr., and a change of 15° Fahr. be capable of inducing a strain of one ton per square inch in wrought iron, it follows that this variation in temperature, unless provided for, will induce a strain of 5.5 tons per square inch. In large girders and similar constructions, protected in many instances by slightly non-conducting paints, the extremes of temperature acting only during a short portion of the day have not time to affect the iron to the extent just stated, an allowance of 7-16 in. for each 100 ft. in length being found sufficient in practice in this country. Now 7-16 in. is equal to 1-2743 of 100 ft., and as iron within working limits stretches about 1-1000 of its length for each ton strain per square inch, it follows that the strain caused in this country in ironwork, without proper provision made for changes due to temperature, will be to 1 ton as 1-2743 is to 1-1000, that is equivalent to a strain of a little over 3½ tons per square inch. Many positions at once suggest themselves where the temperature will be about the same at all seasons of the year, and where consequently no provision need be made for expansion and contraction due to changes of temperature.

Enough has now been said to show the fallacy of the reasoning, and want of perception on the part of those engineers who so often site instances of bridges which have not moved at the abutments for years, through the rusting up of bed plates, or through a want of proper provision being made in the first instance; forgetting that very considerable strains may be brought upon the bridge even although it may be so jammed at its abutments as to show no movement whatever at those points. It might with equal justice be said that ice in the process of freezing does not exert a very large expansive force, simply because in some particular instance a ball filled with water did not burst on the water assuming the solid form, the fact alone being in this case, as often happens with a bridge, the strength and elasticity of the material were such as to stand the strain without fracture.

The circumstances already mentioned taken into consideration with the fact that small rods may be cottered or screwed up by one man to such an extent as to double the strain put upon them, and that bars are often, after being heated and drifted, rivetted up in place hot, may cause the calculated strain per square inch to be nearly doubled; and to exceed the limit of elasticity of the iron, in which case the destruction of the structure is only a question of time.

The limit of elasticity is defined by some authorities as that strain which will cause a permanent set to take place in the iron. This can mean nothing, as the smallest possible strain will produce a permanent set which can be detected if sufficiently accurate and delicate instruments are at hand for the purpose. Thus it might be said that 3 tons per square inch was the limit of elasticity of some iron experimented upon by Edwin Clarke, for he states the permanent set produced by the load to be 1-468750 of the length of the rod.

The limit of elasticity from a strictly theoretical point of view is that point at which the elongation ceases to

* Paper read before the Liverpool Engineering Society, June 30th, 1877.

be in proportion to the additional strain; but so far as can concern a practical engineer it should rather be defined as that point up to which the same strain will not produce an increasing permanent set however often repeated. A few figures will perhaps better convey the meaning of this important definition, and leave less room for misconception as to what it really implies.

If a bar of iron be subjected to a strain of 8 tons, it will stretch a certain amount, and on the removal of the 8 tons will nearly attain its former length. The difference between its length after having been subjected to the strain and its original length is termed its permanent set. If the strain of 8 tons be again put on the bar, and on its removal the permanent set is found to be increased, the load of 8 tons exceeds the limit of elasticity. If on the other hand the permanent set is found not to be increased by any number of applications of this load, 8 tons is said to be within the limit of elasticity of the iron experimented upon. For good ordinary iron the limit of elasticity may be taken at 8 or 8½ tons per square inch.

From this it is seen that if such a strain is put upon iron as to cause the permanent set to increase ever so little at each application, by repeated application the bar will continue to elongate and the structure of which it forms a part must ultimately fall [it may be in one or it may not be for a hundred years]. This is one reason why the giving way of a railway bridge which may have stood a considerable time should not excite surprise. The weight of engines and rolling stock have of late years been so much increased that the structure may be destroyed even although it was originally designed so that the iron might not have a greater working strain than 5 tons per square inch, which would give a factor of safety of 4. After considering the matter it is evident that if time be taken into the calculations, and the limit of elasticity be assumed at 8 tons per square inch, this factor of safety of 4, even assuming the original rolling loads, is reduced to 1.6.

The skeleton or outline of the structure having been definitely decided upon, and the strains on the various members ascertained, the next point to be considered is the arrangement of the iron to meet these strains. The art of doing this properly and economically can alone be taught by experience, and may be said to be one of the beaconless rocks on which engineers who have not been through the shops are liable to be shipwrecked.

In apportioning the proper amount of material to meet the strain, the first care should be to employ as nearly as possible only iron of the economical sections, weights, and lengths to be obtained readily in the iron market. This being so, a few particulars of the weights and sizes of the plates and rolled sections of iron may not be out of place.

Staffordshire iron, although appearing in nearly every engineer's specification, is seldom employed in the construction of girders; this iron, to be obtained at the market rates, being small in size. South Staffordshire plates, to cost ordinary prices, must not be over 4 cwt. in weight, 15 ft. in length, 4 ft. in width, and about 30 superficial feet in area; but, at an additional cost of about £5 per ton, they may be had up to 20 ft. in length and 7 cwt. in weight.

Angles, tees, and other rolled sections of this iron can be obtained in lengths up to 30 ft. or 35 ft. without extra cost, providing they do not weigh more than 4 cwt. and the sum of the sides does not exceed eight or nine united inches. With larger sections such as H iron, having a depth of about 12 in. the cost will be something over 20 per cent. more than for rolled sections complying with the above conditions.

Bars to be had without extras must not be more than 6 in. in width, but they are rolled 8 in. or 9 in. at a small additional price, and can be obtained up to 12 in. in width from some manufacturers.

The influence which this question of size of iron has on designs is at once evident in the case of a plate girder, say 65 ft. span, to carry a load of 12 cwt. per foot run. Taking into consideration the theoretical and practical questions affecting the economical depth of such a girder, it will be found to be about 5 ft. 6 in., but the fact that plates are not rolled above 4 ft. 6 in. in width, at a reasonable price, modifies all other considerations and fixes this as the proper depth to make the girder, as in the ordinary state of things it would not be policy to use short plates and plate the web vertically.

The best Yorkshire iron, such as Low Moor, Bowling and Farnley, ought to be used only in such positions of the work as require much bending or complicated forging, the prices for such iron being more than double that of ordinary iron. The extras also begin at very small sizes; for instance, Low Moor plates to be purchased at ordinary quotations must not be over 2½ cwt. in weight. Both Low Moor and South Staffordshire irons exhibit a uniformity of quality seldom attainable in iron from other districts; but manufacturers of Lancashire, Welsh, Scotch and North Country iron are quite capable of supplying a material of sufficiently good and uniform quality for ordinary girder work.

The Cleveland district may in fact be said to be fast becoming the principal iron manufacturing centre of this country; the science and energy displayed by some ironmasters having so far improved the quality of some brands, that plates can be obtained possessing as great a tensile strength, both with and across the fibre, as those from Staffordshire, but they are not, as a rule, equal to the latter in toughness. Extra care should therefore be taken to test and thoroughly ascertain the quality of the iron as it is sometimes very brittle, and a moderate specification should be rigidly enforced. Many shipbuilders and other iron users are very lax as to the quality of iron and so it happens that ship plates are looked upon with suspicion by engineers. Apart from any experience with these plates, this want of confidence is to some extent justified by the fact that, notwithstanding their large size, they are classed among the cheapest iron in the market. This, speaking broadly, must denote that the material of which they are composed is not equal to that used for other purposes. Another feature to be guarded against in this iron is the fact that it is nearly always bare in thickness. Ironmasters are prone to roll thick plates, but they are not allowed to exercise their bent, shipbuilders having them too much under control. An imperceptible diminution in the thickness of iron throughout the ship makes an appreciable difference in the cost of construction. The best means of guarding against bare places, is to specify that ½ in. plates shall weigh 20 lbs. per superficial foot and other thicknesses in proportion. An allowance of 5 per cent. for iron above ½ in. thick and 7½ to 10 per cent. for iron below that thickness is usual, but no payment should be made for any increase in weight above that specified.

Cleveland plates can be obtained, without additional cost, in sizes scarcely attainable in iron from other districts. They can be had without extras up to 21 ft. in length 4 ft. 6 in. in width and 12 cwt. in weight, providing the area of the plate does not exceed 56 superficial feet.

The extras charged on Lancashire, Welsh, and Scotch irons, speaking generally are intermediate between those for that from the South Staffordshire and Cleveland districts.

Ironmasters are to some extent averse to testing. The author was once advised by one of these gentlemen of high standing to exhibit his knowledge of the subject by simply specifying "best merchantable iron" and if from inspection it was found not to be good it could then be tested. He also hinted that tests are instituted to exhibit the cleverness of engineers, instead of which they simply expose ignorance, and no doubt there is often room for such remarks. Testing is about the only means at the disposal of an engineer to obtain really what he wants. It is next to useless to specify for certain brands of iron with a view of getting a definite quality, as in ordinary iron, such as is used in girder work, the brands carry very little weight, the "best" of one maker being often equal to the "best best" of another whose treble "best" plates may not be equal to the "best best" of a third master; in fact, a long apprenticeship to the iron trade is necessary to render one capable of forming any idea of the quality of ordinary iron by their means alone.

It is not advisable to restrict the iron master by stating the method of manufacture to be pursued. He will in most cases be best able to judge of the processes to be followed in order to procure a specified result. It is a matter for congratulation that really practical and reliable men are to be met who stand out in brilliant contrast to the superficial and narrow minded individuals who appropriate to themselves an honored but quite unearned title.

An instance came under the author's notice where a fracture of rod iron was shown to one of those so-called practical men, and said to be good; on the other end of the rod, not six inches in length, being presented to him, it was pronounced little better than trash. The difference in appearence was almost entirely due to the mode of fracture. In another instance a lot of "Low Moor" fire-box stays were rejected because they were crystalline; but on these being tested they were found to bend over cold white flat, without exhibiting the slightest sign of a crack, and to be in every way of the very best quality.

All things being considered no engineer need hesitate to own that he is unable to determine the quality of iron by its appearance. Men who have given much more time than most engineers can devote to the study of iron often err in their judgment of this material and are generally backward in offering an opinion offhand.

The first lot of average iron supplied under an ordinary specification will, as a rule, be very variable in quality, but, as previously pointed out, the ironmaster can and after a little grumbling will, supply iron of uniform quality, and possessing a fair standard of strength and toughness providing the engineer is firm and knows when he has got what he wants. A strain of 20 tons per square inch and 6 per cent. elongation with the fibre, and 18 tons per square inch and 3 per cent elongation across the fibre for plates, 22 tons per square inch and 9 per cent. elongation for angles and tees, and 24 tons per square inch and 15 per cent. elongation for rod iron are not too high a requirment for ordinary iron.

Many engineers in place of specifying the iron to elongate a certain amount before breaking, require that the fractured area shall be less than the original area by a specified percentage. When the tests are carried out at testing works provided with the necessary gauges, no doubt either may be ascertained with equal precision, but to measure and calculate the contraction of area requires more care than is usually bestowed on testing by those in charge of the construction of ordinary ironwork.

Let it be supposed that the errors in measurement before and after testing amount jointly to only 1-100 in. of an inch each dimension; then, if the total contraction of area be assumed at the fair amount of 10 per cent., the error will amount to two per cent. if the testing section be 1 in. by 1 in.; but if the testing section be (for the sake of argument) ½in. by ¼in. this error will be doubled, so that in the latter case the contraction of area would be 6 or 14 per cent. in place of 10 per cent., according to whether the errors in measurement were taken more or less. If the section be increased to 2 in. by ½in, the exact amount of error can not be determined without knowing exactly to what extent the difference in dimensions affect the contraction of the iron each way, but it will be something over 2 and under 4 per cent. By taking elongation, which is a simpler operation, the maximum error, even assuming an error in measurement of 1-32in, in place of 1-100in., will be only ½ per cent. on a test length of 6in. A further reason for preferring to specify "elongation" in place of "contraction of area" is that iron plates are sometimes not uniform in quality throughout, consequently the contraction may take place only at the joint of fracture, whilst the adjacent portions may be hard and brittle. It must be remembered that all iron when tested will show a greater amount of elongation and contraction of area in the vicinity of the fracture than elsewhere, should this happen to any undue extent it would be detected by the elongation test, as it is probable the iron would not stretch sufficiently in a short length to comply with the specification. This is no visionary objection, for before you this evening is a bar of iron which, to all outward appearances, is of uniform quality, whilst it will be perceived by the fracture that one-half is little better than cast iron, the other being fibrous and good.

The tests given must be considered to apply to ordinary plates as generally rolled, and not to erratic or "cross piled" plates, as in the process of manufacture the strength of the plate both in the direction of its length and across it may be much modified; for instance, the author requiring some plates about 10 ft. by 1 ft. 3 in., to be bent to a small radius transversely to their length, they were specified to be cross piled, the

result was the iron stood 22¾ tons per square inch and elongated 10 per cent. across the plate, and only 18¾ tons per square inch and 3 per cent. elongation with the length of the plate that is in a direction parallel to the revolutions of the roller. This is, perhaps, a result not always to be anticipated, but some ironmasters are quite prepared to give iron in moderate sizes, of uniform quality and strength, both with the length and across the plate, providing the tests are somewhat less than that specified for ordinary plates with the fibres.

In preparing the samples for testing, the best way is to drill them out of the plate or angle iron, and chip the portion to be tested down to about the required size, or if preferred they may be slotted out. What ever means be resorted to, great care should be taken to file out all tool marks, and the result will be more uniform and to be depended upon if the samples be "draw filed" along the edges of the portion to be tested. The other portions may of course be left rough. The parallel portion to be tested should run in with curves of large radii to the portions through which the pin-holes are drilled. This is necessary, as in the event of there being the slightest shoulder at either of these points it will have the same effect as a nick in the iron, at which point the fracture is nearly certain to take place, and consequently the test of tensile strength and elongation is rendered worthless.

The testing section should be of uniform width for a length of about 6½in., the exact distance between the centre punch marks being 6¼in., or 100 sixteenths of an inch. Every sixteenth elongation after fracture will then represent 1 per cent.

It is very necessary to have plenty of metal around the pin-holes, which ought to be exactly in a line with the centre line of the testing portion. If this point is overlooked a cross strain may be brought upon the iron, which will invalidate the test.

The foregoing tests of iron, taken in conjunction with a proper examination of the plates by the inspector, and such other work tests as he may from time to time carry out, is all that is requisite to obtain iron of a sufficiently good quality for average iron work.

(*To be Continued*).

REPORT ON VARIOUS METHODS OF CONSOLIDATING EARTH THAT HAS SLIPPED.

BY M. COMOY,

Inspector General (Retired) of Ponts et Chaussees.

Translated for ENGINEERING NEWS by Brevet Col. Wm. E. MERRILL, U. S. A.

(*Continued from page 257.*)

2d.—Slip of the hillside of Avrilly adjacent to the canal from Roanne to Digoin.

Near the village of Avrilly the hillside on the left bank of the Loire, whose top is about 100 feet above the bottom of the valley, touches the present bed of the river for a length of 1000 feet.

When the canal from Roanne to Digoin, which is located on the left bank of the Loire, was built, it became necessary at this point to cross some very broken ground apparently due to some very ancient slides, and lastly to a slide that took place in 1825.

The canal was placed as near as possible to the bank of the river, and the right embankment, lying between the canal and the Loire, was strengthened by a row of piles supported by heavy rip-rap on the outside, and by a berm also backed by rip-rap. The slopes of the embankment and of the berm were both paved.

In addition, at the narrowest and most threatening point, the width of the bottom of the canal was reduced to 22 feet 2 inches, and the slope of the left bank was replaced by a retaining wall for a length of 350 feet.

In 1856, after the rains which I mentioned in a preceding paragraph, new slides took place on the Avrilly hillside. The right bank of the canal was not overturned; but the retaining wall of the left bank was pushed by the sliding earth and moved bodily towards the right bank, making the bottom of the canal rise 3 feet above its proper level, and only leaving the canal a width of 10 feet along the whole length of the wall.

The slips of 1856, although important, did not extend to the top of the hillside. The intersection with the natural surface bed on which slipping took place was about half way up the slope.

To stop these slips and to prevent their recurrence, the mass of earth in motion was sub-divided by means of four transversal fluid drains placed at distances apart of about 130 feet. The stone filling in these drains has a thickness of 4 feet. They extend down to the bed on which sliding took place. They terminate in a longitudinal drain, 6½ feet wide, 10 feet deep, and 750 feet long. This longitudinal drain, which takes the place of the lateral drainage ditch of the canal, carries all the water which it receives to the lowest point of its length, near the second transversal drain, where a cast-iron pipe, 10 inches in diameter, laid under the canal, empties into the Loire the water from the drains.

The transversal drains were extended to the foot of the hill, always following the bed of the slide. Their lengths varied from 90 to 120 feet. Their depths were 6½ feet at the foot of the hill and 8 feet near the longitudinal drain.

A greater depth was not given to the drains in order to lessen the expense. The excavations were left open up to the surface of the slipped earth, which was graded.

By means of loose rock placed at the heads of the transversal drains, and surface drains on the slope of the hillside, the water that oozes through the soil is led into the drains.

In 1856 the engineers were only able to build the first three transversal drains, counting from the upper end, the corresponding part of the longitudinal drain, and to lay the cast-iron pipe under the canal. Afterwards the retaining wall of the left bank was demolished and the trunk of the canal throughout the damaged portion was restored to its normal section.

During the winter of 1856 and 57 a slight movement took place in the left embankment of the canal over a length of 200 feet. The maximum amount of this movement was 5 inches.

In 1857 a fourth transversal drain, the lower one, was constructed, and the longitudinal drain was finished.

In addition, with a view to opposing any movement like that of the winter of 1856–57, there were driven on the two sides of the longitudinal drain, along a length of 440 feet, piles 20 feet long placed in quincunx order, with intervals of 10 feet between those in the same line. The piles of the two lines were connected together at their tops by stringers for a length of about 130 feet where the earth seemed to have the least solidity.

The portion of the interior slope of the left embankment which had encroached a little at the canal, was afterwards restored to its normal condition.

These works of consolidating cost about $12,000. They cover a length of 750 feet. Consequently the repairs cost $16 per running foot.

Since 1857 no other movement has taken place on the hillside of Avrilly, nor in the corresponding part of the canal from Roanne to Degoin.

3d.—Land-slide of the hillside of La Negresse on the railroad from Bayonne to Irun.

The railroad from Bayonne to Irun, near the station of Biarritz and before reaching the La Négresse tunnel, runs on the flank of an upright hillside at whose foot is the small but rather deep lake called Mouriscot.

The grade of the railroad is about 90 feet above the surface of the lake.

On this very broken hillside the railroad is sometimes in excavation and sometimes in embankment.

An embankment about 400 feet long, and 13 feet in maximum height, situated near the Berlin house, was nearly completed in 1861 when the filling began to slide towards the lake.

With the view of stopping this movement, an embankment was built in 1862 at the foot of the hillside.

This work did not stop the sliding of the railroad fill. The earth of this fill was not in fact the only earth that had been loosened. A deep crack appeared in the hillside itself and the earth of the hillside having been started, dragged with it that of the railroad fill.

The movement was felt as far as the interior of the lake, whose bottom was raised.

The exact shape of the curved bed on which the sliding took place has not been reported. But the raising of the bed of the lake leads one to think that the lower part of the curve extended below the level of the water of the lakes.

The upper crevices of the slip were situated beyond the axis of the railroad, and the slip embraced a length of 330 feet measured along the shores of the lake.

Towards the end of June, 1862, the railroad fill had settled about ten feet. A house situated below the railroad, in the midst of the moving earth, had been carried away and destroyed.

It was then decided to make at right angles to the hillside two capacious drains 103 feet apart, dividing into three parts the mass of disturbed earth.

These drains, filled with stone, begin a little above the axis of the railroad and extend to lake Mouriscot where they empty their waters.

The bottoms of the drains at their lower ends were placed very nearly at a level with the lake, whence they gradually rise.

The width of the drains is 20 feet for the 130 feet commencing at the upper end, and only 10 feet for the remainder of their length. The depth of the stone is 20 feet as the maximum in the first part, and 10 feet in the second.

The two transversal drains are joined at their heads by little drains parallel to the axis of the railroad.

On the soil thus drained the fills of the railroad have been re-constructed in accordance with the original design.

These works were carried out during the last months of 1863 and the first months of 1864. They necessitated an expenditure of $4,500.

The slip had a length of 330 feet measured on the shores of the lake. The works of repair have consequently cost about $14 per running foot.

The results obtained are satisfactory. The following are the terms in which the railroad engineers report on the matter:

"The last fillings on the railroad have kept in good condition. The slides have not re-appeared, but there has been some slight subsidence, that can still be noticed after heavy rains. The roadbed, however, does not lose its form, and it is easily kept at its normal level by slight fillings."

4th.—Slips of the side-slopes of excavations and embankments on the railroad from Paris to Lyons and the Mediterranean.

Slips of clay soils were numerous on the lines of the net work of railroads between Paris and Lyons and the Mediterranean, and they still occur from time to time on new lines under construction.

All of these damages were repaired on a uniform system, in accordance with plans whose efficiency had been proved.

I will not describe here any particular case, but the model adopted.

Slips in the side-slopes of cuts are repaired by means of transversal partition walls of dry stone (blind drains) at distances apart of 65 feet.

These drains are sunk sufficiently deep to rest throughout on soil that has not been disturbed by the slip.

This solid soil is cut into slips so that the foundation is always below the curved bed on which the sliding took place. In order to facilitate the flow of water a slope of one in ten is given to the flattest portions of the steps.

The trenches in which the blind drains are constructed were generally sunk as vertically as possible by means of braces and sheet-piling.

Sometimes, when the trenches are to be quite deep, or are near tracks that are in use, work is carried on by little subterranean galleries which begin where the bottom of the stone filling is to be and are successively superposed. The fillings have a depth of from 3 to 7 feet, according to the height of the slope to be repaired.

The upper surface of the filling coincides with the surface of the slope and remains exposed.

The different drains are connected by vertical, ogive or circular arches, also of dry stone. These arches appear on the surface, and extend into the ground to a greater or less depth, depending on the fluidity of the soil.

Before filling the drains with stone the bottom is covered with a layer of concrete from 12 to 16 inches thick, and then a little culvert not more than 8 inches in width and height is built on the bottom of the trench.

Similarly the side slopes of embankments are repaired by means of transversal drains. These drains are arranged and built like those which I have just de-

scribed, with this difference, that the foundations do not stop at the curved bed on which sliding took place, but are carried down to the natural solid soil.

This arrangement is required by the lack of solidity which is generally found in fills. We thus avoid the breaks which the settlement of fills causes in stonework resting on them.

It sometimes happens that slips occur at the same time on both side slopes of a road. The drains of the two slopes are then placed opposite each other, and they are connected by means of another drain, 6½ feet in depth, constructed by making a tunnel under the embankment, or a simple trench if the latter is low.

Sometimes slips occur in hillsides on whose flanks railroads are constructed partly by cut and partly by fill.

The same system of transversal blind drains is applied to these as to slips of side-slopes in cuttings; in all cases the stone filling rests on the solid earth below the curved bed on which the slipping occurred.

The height of the dry masonry of these drains is reduced under the road-bed of the railway, the portion omitted being replaced by the ordinary embankment.

The cost of repairing a side-slope in cutting amounts to about $10 per running foot for a height of slope of from 20 to 25 feet, and to about $15 for a height of from 30 to 35 feet.

That of a side-slope of an embankment of from 15 to 20 feet in height amounts to about $8 per running foot; and when slips have taken place on both sides at the same time the repairs, including the tunnel that unites the drains of the two side-slopes, amount to about $30 per running foot.

5th.—Slips in the Breval Cut on the Railroad from Paris to Cherbourg.

The cuts of the Bréval tunnel, on the railroad from Paris to Cherbourg, have been the cause of important works of consolidation. It is the cut on the Cherbourg side with which we now have to deal.

This cut is nearly 3000 feet long, and it has a maximum depth of about 60 feet. It is opened through clays and fine argillaceous sands belonging to the lower tertiary formation. The marls and limestones of the same formation are found below the bottom of the cut.

In 1858 quite a large slip occurred in the side-slope on the right side of the cut, looking from Paris towards Cherbourg.

This slip undoubtedly started a large mass of earth, as also did the other slips which will be mentioned further on. The limits of the disturbance of the soil have not been reported. But the engineers decided to construct in front of the whole disturbed mass a retaining wall, 486 feet long, that would resist it.

In the original arrangement the exterior counterforts along the length of the wall did not exist. The wall, which is 10 feet high above the rail, and is sunk to a depth of 3¼ feet in the marl that covers the bottom of the cut, had a front of hydraulic masonry 28 inches thick at the top, and 3 feet 8 inches at the base, and a backing of dry masonry having a uniform thickness of 4 feet 7 inches.

It was very soon seen that this wall did not have the necessary solidity. It underwent a movement which was shown by a marked undulation of its upper crest. Counterforts were then built to strengthen the wall. These counterforts have a width of 5 feet, and are spaced at intervals of 30 feet between centres. They stopped the movement of the wall.

In 1861 a new slip, more extended than the first, took place near the head of the tunnel, in the same slope of the cutting.

Again, it was decided to oppose the entire mass of disturbed earth by a retaining wall. This wall extends over the distance of 650 feet between the portal of the tunnel and the wall built in 1858. But, enlightened by the experience of 1858, this new wall was wholly built with hydraulic mortar, and as sufficient thickness could not be given to it on account of difficulties as to foundations, it was provided with counterforts. Along the 280 feet beginning at the portal of the tunnel, in which the height of the wall, which varies throughout its length, is greatest and is as much as 13 feet, the counterforts are 6½ feet wide with 16½ feet of projection, and are spaced at intervals of 13 feet between centres. Along the remainder of the wall up to its junction with the wall of 1858, the counterforts have only a thickness of 5 feet, and are spaced at 30 feet between centres.

This wall has resisted well, no movement having appeared since its construction.

In 1867 two more slips occurred in the same side slope.

The first was a continuation of the slip of 1858, and along a length of 50 feet it even broke up the earth which had been first started in 1858. This slip had a total length of 115 feet, measured at the foot of the slope.

In the very beginning of the movement it was observed that the retaining wall built in 1868 had been pushed forward. Strong struts were then placed along the threatened portion of this wall, which presented its overflow and stopped the movement of earth.

It was unadvisable to reconstruct this part of the wall of 1858, in spite of the injury it had sustained, because its demolition would have been followed by the fall of all the earth detached from the slope. But the old wall was strengthened by introducing new counterforts between those that had previously been added to this wall. The new counterforts, built with cement mortar, were 5 feet thick, and were spaced 10 feet between centres. They gave a sufficient resistance to this portion of the wall of 1858, which since this time has experienced no movement.

The earth disturbed in 1867 over a length of 65 feet beyond the end of the wall of 1858, was held up by a retaining wall built in 1868 of which I will now speak.

I said just above that two slips took place in 1867.

The second slip occurred at a short distance from the first, in a part of the cut not quite so deep, and it extended over a length of 394 feet.

A retaining wall 880 feet long, forming a continuation of the one built in 1858 was constructed along these disturbed sections.

This wall, wholly built with hydraulic mortar like that of 1861, is thicker than the latter and has deeper foundations. It is provided with counterforts 5 feet wide spaced 30 feet between centres.

In the same year 1868, in order to prevent new slips along the remainder of the cut, a retaining wall 787 feet long was constructed forming a continuation of the preceding; it extended to within 165 feet of the end of the cut. This wall was built without counterforts.

All of these works have stood well. No movement has appeared in the Bréval cut since 1868.

The total cost of all the works of consolidation in the cut was $97,116, not counting $6,405 applied to the maintenance of a single track during the construction of the works; an expense which although rendered necessary by the slips ought not to enter into the cost of repairs properly so called. The total length of the walls being 2,800 feet, the total cost given above makes the average cost per running foot amount to $35.

This cost is subdivided as follows:

In the portion repaired in 1861, where the cut attains its maximum depth, averaging 55 feet including the spoil banks, cost amounted to $41,640 for a length of 650 feet, or $64 per running foot.

In the following portion, repaired in 1858, where the depth of the cut, spoil banks included, averages 52 feet, the cost was $21,498 for a length of 486 feet, or $44 per running foot.

For the remainder of the length, the cut has the average depth of 43 feet along the counterforts, and 30 feet along the wall that is unsupplied with these appendages, and the cost was $33,978 for 1666 feet of length, or $20 per running foot.

To complete the description of these works I will add that the disturbed slopes have been drained in order to collect the water that oozes out and convey it to the drain of the railway, and that numerous openings have been left in the retaining walls for this purpose.

(To be continued.)

LIST OF PROVINCIAL LAND SURVEYORS IN ONTARIO.

(Concluded from page 257.)

Augustine McDonell, Chatham; John McLatchie, Township of Templeton, or Ottawa; Bolton McGrath, Aylmer Co. Ottawa; Wm. Graham McGeorge, Chatham; John Joseph McGee, Peterboro; James Marshall, Kinloss Co., Bruce; John McAree, Eramosa Township; Wm. John Macdonald, Newbury; Balfour N. Molesworth, Toronto; H. R. McEvoy, St. Mary's; J. K. McLean, Mt. Forest; Jas. A. McMillan, London; John Newman, Quebec; Thomas Webb Nash, Kingston; Henry Northcote, Mimico; Wm. Henry Edward Napier, Germany; Alexander Niven, Haliburton P. O.; R. Morris Newman, Ft. Wayne, Ind.; John O'Mara, Newbury; John C. Power O'Hanly, Ottawa City; David C. O'Keeffe, Hamilton; John Oliver, Toronto; Patrick O'Beirne, Grimsby; Edward O'Flynn, Chatham; Wm. Ogilvie Gloucester Township; John H. Ogilvie, Campbellford; Reuben Preston, Collingwood; Aylsworth B. Perry, Violet, C. W.; Joseph S. Peterson, United States; James Pollock, Galt; Frederick F. Passmore, Toronto; Samuel Peters, London; William Perceval, Ireland; Peter Alexander Peterson, Toronto; Nathan Fellows Perry, Violet; Richard Purdour, Toronto; William Pearce, Tyrconnel; Allan Poyntz, Patrick, Ottawa; Frank Purvis, Otterville; Robert T. Pope Bracebridge; Charles Rankine, Sydenham, Owen Sound; Josias Richey Smith's Falls; Frederick P. Rubidge, Ottawa; Richard Rees, Wales; John Reid, Peterborough; Mathew Ryle, England; John Robertson, Fitroy Harbor; Arthur Rankine, Sandwich; Jonathan Rodgers; Azariah Root; James Richey, Packenham. William Robinson, London; W. R. Rombough, Dunham, Bentinck, P. O.; T. S. Rubidge, Morrisburg; Orpheus Robinson, Brantford; William Ralph, British Columbia; Charles Edward Rankin, Bridgewater P. O. Richard Gordon M. Robertson, Port Hope; James Hales Reid, India; Marshall Bidwell Rombough, Centreville, Camden Tp.; Andrew Lindsay Russell, Ottawa City; Charles Edmond Roberts, Hull, C. E.; Geo Robinson, St. Marys; Fred. William Redden, Southampton; John Lestock Reid, Bowmanville; George Rainboth, Aylmer, Que; James Henry Ruffenstein, Pembroke; Alexander Lord Russell, Ottawa; Edmund Jas. Armstrong Rodgers, Colbourne; George Urquart, Ryley, Collingwood; Claudius Shaw; John Smith, Jr., Washington; Christopher Smith; Benjamin Springer, Strathroy; Henry Strange Rockwood, Eramosa; Lemuel Shurtliff; William Smiley, Woodstock; Milton C. Schofield, Durham; John Shier, Whitby; Albert P. Salter, Chatham; Duncan Sinclair, Ottawa: John Allen Snow, Hull, C. E.; H. P. Savigny, Toronto; Wm. Smith, Innerkip; James Dyson Slater, Ottawa; Donald Sinclair, Ottawa City; George Alexander Stewart, Port Hope; Lawrence H. Shortt, SanFrancisco; Wm. Alexander Simpson, Guelph; F. H. Lynch Staunton, Dundas; Wm. Sanders, Barrie; Alexander Sproat, Walkerton; Andrew Brown Scott, Brampton; William Spry, Owen Sound; Robert Sparks, Ottawa; Charles Sproat, Toronto; Edmund Seager, Jr., Alliston P. O.; Henry Smith, Guelph; George Albert Simpson, Picton; Thomas Scane, Ridgetown P. O.; Elihu Stewart, Collingwood; John Frederick Snow, Hull, Que.; John Strathern, Orillia; Henry W. Selby, Stayner; William Tracey, Williamsburg; John Tully, Nova Scotia; William, Ryan Thistle, Ottawa; William Græme Tompkins, England; Eugene E. Tache, Quebec; Augustus Clifford Thomson, Barrie; Charles Newland Trew, Toronto; Wilton Redwar Turner, Durham; Thomas Henry Tracy, London; Edward Wm. Thomson, Point Fortune, Que.; Isaac Traynor, Mt. Forest; William Thos. Thompson, Cannington; Chas. Unwin, Toronto; Edgeworth Richard Ussher, New Zealand; William Vondenvelden; Alexander Vidal, Sarnia; John Pennefather, Vansittart, India; James West, South Mountain P. O.; Robert Walshe, Lloydtown; Thos. W. Walshe, Simcoe; Henry White, Toronto; Alexander Wilkenson, Sandwich; Wm. George Wonham, Ingersoll; Henry O. Wood, Ottawa; Thos. Weatherald, Goderich; C. J. Wheelock, Orangeville; Wm. Wagner, Montreal; Hugh Wilson, Mount Forest; Adam Clark Webb, Brighton; Edward Webb, Toronto; Vernon Bagley Wadsworth, Toronto; David Williams, Trenton; James Warren, Lucknow; Alfred Willson, Toronto; Charles Everard Wolff, Ottawa; Fred. W. Wilkins, Belleville; William Edward Yarnold, Prince Albert P. O. Reach.

Col. Gordon, Governor General of Upper Egypt, has made a contract with an English house for four very light-draft steel steamers, to be used in the Albert Nyanza and the rivers of Central Africa. The steamers will be carried overland by negroes, and it is estimated that a force of 4,000 carriers will be required.

THE RIVER THAMES.*

BY JOHN BALDRY REDMAN, M. INST. C. E.

(*Continued from page 259.*)

That the embankments can have little effect in stopping the tides, as some persons assume, is evident from the fact that the minimum width, 700 feet, and consequent maximum depth, viz., 15 feet at low water, existed prior to those works at the Millbank Penitentiary Embankment, which had gauged the stream for thirty years prior to their erection. This minimum has been somewhat increased by the setting back of the Albert (Surrey) Embankment. To show the Embankments are recuperative, and afford a compensation by raising the tidal column in exchange for what is abstracted, it may be stated that, assuming the surface at high water from Blackfriars to Battersea is raised 6 inches, for a length of 5 miles, with an average width of 1,000 feet, a corresponding equivalent would be afforded, viz., 368,000 tons. However, 750 feet is more probably the average width, and this gives 276,000 tons as compensation. If this be estimated between Blackfriars and Teddington, a length of 19 miles, at an average width of 500 feet only, the amount is 700,000 tons, nearly. This approximates closely to the estimate of Captain Maughan, for many years Dock Master at the London Docks. He estimated the areas under the Acts of 1862–63 authorized to be embanked as follows:—

	Superficial feet.
On the north shore from Westminster to Blackfriars	1,645,457
From the Houses of Parliament to Chelsea	502,520
Surrey shore below Westminster Bridge	720,000
	2,867,977

This area he assumed to be covered at high water of spring tides by 10 feet depth of water, an extreme depth, and this yielded a tidal abstraction equal to 800,000 tons. This is small, although it is compensated for by the action of the Embankments, considering the enormous amount of additional tidal water admitted by the removal of old London Bridge, thus,

Miles.	Feet.	Feet.	Tons.
20 ×	750 ×	3, average increased range,	=6,529,466
or—			
20 ×	500 ×	3, " " "	=4,420,000

In fact the latter and smaller amount is five or six times the quantity affected by the Embankments.

HIGH TIDE, 20TH OF MARCH, 1874.

The tide of the 20th of March, 1874, attained an altitude of 4 feet 4 inches above Trinity standard, 9 inches in excess of that in November 1852, which latter was aided by a land flood, and thus higher than any previously recorded. This directed attention to the general question of the river, and the completion of the Embankment and raising the wharves and banks in the lower reaches have been publicly discussed and entertained.

HIGH TIDE, 15TH OF NOVEMBER, 1875.

This tide, the result of the great westerly gale of Sunday, 14th of November, aided by a heavy land flood is the highest on record in the Port of London, having attained an altitude of 4 feet 9 inches above Trinity standard; but it was relatively higher, exceeding the Admiralty calculated range by 3 feet 3 inches; whereas that of the 20th of March, 1874 was only 2 feet 2 inches above the Admiralty estimate. The lamentable results attendant on the periodical overflowing of the Thames in the low-lying and poorer districts of the metropolis cannot be well exaggerated.†

As regards the land floods of the Upper Thames, it has been estimated by Mr. Symons, to show the impossibility of providing reservoirs, that storage would be required for 160,000,000,000 gallons, or for 714,285,714 tons of water, equal to from three to four times the daily ordinary tidal volume from Teddington to Gravesend. The winter flood of 1875, at Windsor, taken by Professor Unwin, Assoc. Inst. C. E., amounted to 14,102 cubic feet per second, or to 33,723,925 tons daily, so that Mr. Symons' estimate of storage would be for twenty-one days of the great flood. The ordinary winter flood at Windsor amounts to 746 cubic feet per second, or to 1,798,302 tons daily, or to $\frac{1}{17.64}$ of the great flood of 1875; and the ordinary daily discharge at Twickenham is 3,250,000 tons.

	March, 1874.		November 15, 1875.		January 1, 1877.		January 2, 1877.		January 31, 1877.	
	Ft.	Inch.	Ft.	Inch.	Ft.	Inch.	Ft.	Inch.	Ft.	Inches.
Dover: Above low water ordinary spring tides	..		21	3	S.W. gale. 19	6	..		24	0 N. to N.W.
Ramsgate: On tide gauge	7th 24	4	23	10	20	..	22	6	26	0
London: Above Trinity standard	10th 23	4	..		..		..		..	
	20th 4	4	4	9	..		4	3	3	7 W. gale; no change to N.
Above Admiralty estimate	N.W. 2	3	W. to N.W. 3	3	..		W. to N.W. 3	4	2	2

At Kingston the maximum discharge in 1866, as given by the Water Supply Commissioners, amounted to 8,000,000,000 gallons daily, or to 35,714,285 tons. Other floods occur, of from 22,322,000 tons to 26,785,000 tons daily.

The average tidal volume of extreme tides above bridge is, as before stated—

	14,750,000 tons;
and below to Gravesend =	92,750,000 "
or	107,500,000 tons for one tide,
or	215,000,000 " daily;
and to	322,500,000 tons,

including 50 per cent. added for equinoctial spring tides, and exceptionally high ranges, due to great gales of wind, so that the land flood water is approximately one-ninth of the tidal water, or rather one-eighteenth, as one half passes off on the ebb; and a depth of 3 inches to 3½ inches of the great metropolitan tide of 4 feet 9 inches above Trinity standard was due to flood water, *i. e.* of the 3 feet 3 inches above the estimated Admiralty range.

Comparing recent great tides, the following are the results:—

	Above Trinity Standard.		Above Admiralty Estimated Range.		Wind.
	Ft.	Inch.	Ft.	Inch.	
20th March, 1874..	4	4	2	2	Northwest.
15th Nov., 1875....	4	9	3	3	Gale; west.
13th March, 1875...	3	9	2	6	Gale; w. to n.
2d January, 1877....	4	3	3	4	Gale; w. to n.

The practical result is, that whereas hitherto a height of 4 feet has been considered the maximum required for the wharves, owing to the great increase of tidal volume consequent on the removal of Old London Bridge, the raising of high water and lowering of low water all the way to Teddington, and the additional range due to the embankments, a minimum height of at least 5 feet above Trinity standard is now required for the metropolitan quay surfaces.

EFFECT OF EMBANKMENTS.

The effect of the embankments has undoubtedly been to raise the level at high water within the metropolitan area above bridge. The amount is estimated by the Author at from 4 inches to 6 inches. On the authority of Mr. Leach, at Teddington the tide of the 20th of March, 1874, made the same height as at Westminster, reaching an altitude of 4 feet 4 inches above Trinity standard, rising above the land water 18 inches, giving 7 feet rise of tide and flowing up to Kingston, where the oscillation of tide was 12 inches; and this tide attained a greater elevation at London Bridge than at Gravesend by 20 inches.

The morning and afternoon tides of the 8th of April, 1874, both rose 21 inches higher at Blackwall than at Gravesend; 10 inches higher at London Bridge than at Blackwall; and at Westminster and Lambeth 4 inches higher than at London Bridge.

INCREASED DEVELOPMENT OF TIDE.

The high tide of the 18th of March, 1874, was higher than the heights given in the Admiralty tide-tables, by 2 feet 2 inches at Blackwall, and 2 feet 5 inches at London Bridge; the tide of the 20th of April, 1874, rising to the calculated height. The average of the twenty-four annual maximum spring tides, as calculated in the Admiralty tide-tables for Sheerness and London, shows how greatly the river has been developed of late years:—

Year.	Sheerness.		London.			
	Ft.	Inch.	Ft.	Inch.	Ft.	Inch.
1849	16	4	19	9	3	5
1869	16	4	20	6	4	2
1874	16	2	20	9	4	7
1876	16	1⅞	20	8⅞	4	7
1877	16	2	20	9⅛	4	7⅛

Increased spring range at London.

In 1799 the range of springs at London Bridge, as ascertained by Russell and Gream for the Trinity Corporation, was only 15 feet; so that, in the last three-quarters of a century, the increased oscillation is 5 feet 9 inches. Of the increased range of 4 feet 7 inches as compared with Sheerness, 3 feet 10 inches are due to the elevation of the surface at high water, and 9 inches to the depression at low water.

By the Admiralty maximum calculated spring ranges for Sheerness and London, from 1845 to 1877 inclusive, it will be seen that at Sheerness the range of spring tides is from 16 feet 10 inches to 17 feet 6 inches, and at London from 10 feet 11 inches to 22 feet 3 inches; and that the greater range at London than at Sheerness increases from 3 feet 1 inch to 4 feet 9 inches; and as there is but 3 feet 10 inches fall at high water, low water must be 11 inches lower than at Sheerness for a large number of tides.

TRINITY STANDARD.

Trinity standard, fixed in 1800 by the Trinity Corporation (39 & 40 Geo. III. c. 47, s. 55), is 12 feet 6 inches above the Ordnance Survey datum of the mean level of the sea, which is 5 feet on the Old Dock sill at Liverpool. The Admiralty datum for low water of springs at Liverpool is 7 feet 9 inches, or 8 feet below the said sill. In London the present Admiralty low water of springs is 20 feet 1 inch below Trinity standard.

The inscription on a stone let into the lower external wing wall of the Hermitage entrance to the London Docks states, "Low water mark is 17 feet & 10 ins. below the lower edge of this stone, settled by the Corporation of the Trinity House Aug. MDCCC.—Vide 39° & 40° Geo. 3rd, Cap. 47, Sec. 55."

This was the Act for the formation of the London Docks, the pioneer measure after the inquiry of 1799. Sec. 54 defined the depth of the docks to be not less "*than within 15 inches of the level of the river at low-water mark*," and sec. 55 said, "the same shall be settled by two of the Elder Brothers of the Trinity House within three calendar months next after the passing of this Act, who shall certify the same in writing under their hands and seals."

This standard high water from which the low water was measured is, 28 feet on the St. Katharine's Dock sill; 22 feet 10 inches on Wapping entrance, London Docks, sill; 25 feet 4 inches on that of upper old Shadwell entrance of London Docks where tides are kept; 23 feet 5½ inches on that of Limehouse entrance of

*A Paper read before the Institution of Civil Engineers, London.

†To show how exceptional were the tides of March, 1874, and November, 1875, it may be mentioned that high water at Dover and Ramsgate attained on the 31st of January, 1877, an altitude exceeding by 2 feet any previously recorded tide at these harbors, and yet the high water in London was 9 inches and 13 inches lower than in the tides of March, 1874, and November, 1875, which thus attained that excess in range whilst the sea level was so much lower. The sudden change of wind from west to northwest driving the sea up the Thames estuary, appears to be the most reasonable explanation of this remarkable anomaly.

South West India Dock; 24 feet 7 inches on East India Dock sill.

In the Minutes of Proceedings Inst. C. E., vol. ii (1843), p. 87, the London Dock Act is referred to as 39 & 40 Geo. III., cap 17, instead of chapter 47.*

HALF-TIDE LEVELS.

The mean level of the sea at Harwich, as determined by Captain Parsons, of H. M. ship "Porcupine," is 11 feet 3 inches below Trinity datum, or 1 foot 3 inches higher than at Liverpool, and 11 feet 2½ inches below Trinity datum at Sheerness, as determined by tidal observations at H. M. dockyard, or 1 foot 3½ inches higher than at Liverpool, and 10 feet below Trinity datum in the Port of London, from tidal observations at the London Docks, or 2 feet 6 inches higher than at Liverpool.

SHEERNESS AND LONDON LOW WATER DIFFERENCE.

Taking the mean spring ranges in London and Sheerness respectively, as worked out in the Admiralty tide-tables, as 20 feet 7 inches and 16 feet, or 10 feet 4 inches and 8 feet half range, the difference of low water stands as follows:—

London.		Sheerness.		Difference.		
Feet.	Inches.	Feet.	Feet.	Inches.	Foot.	Inch.
10	4 +	10 −	8 +	11	2½ =	1 1½

i. e. so much lower in London. The average is, however, really less.

Mr. Lloyd in the "Philosophical Transactions" for 1830, by abstracting certain tides, worked out the result that low water springs, low water neaps, half-tide level, high water neaps, and high water springs were all relatively from 1 foot 8 inches to 2 feet 3 inches higher at London than at Sheerness. But to get these results he took 17 feet 8 inches as the range of springs at Sheerness from dockyard tables kept for three years prior to 1830. Yet at the present time, and as far back as the Admiralty tide-tables are published, the estimated spring range is 16 feet; this difference of 1 foot 8 inches, added to that found by Mr. Lloyd, agrees with the calculated and observed results of the present day. Besides this, although his mean high water at Sheerness agrees with that of the present day, his mean London high water was 18 inches lower, and the mean London high water was then as now 12 inches below Trinity standard, as shown by Sir John Lubbock, and not 2 feet 6 inches as by Mr. Lloyd.

GRAVESEND LOW WATER.

The neap low water is not really a plane or dead level, nor the low water springs, as it will be seen low water at Gravesend is lower than in London by 9 inches, and lower than at Sheerness by nearly 12 inches, the fall at low water continuing below Gravesend, until met and overcome by the young flood from Sheerness.

SHEERNESS, GRAVESEND, LONDON, CHELSEA AND BATTERSEA HIGH WATER.

A comparison of tidal observations over a series of ten years, 1833–1843, at Sheerness, Gravesend, the London Docks, Chelsea, and Battersea, taken by various authorities, shows the following results:—The high-water level for the mean of two years of these tides was 1 foot 5 inches higher at Gravesend than at Sheerness, a distance of 21 miles, with a difference of time of half an hour, or later, high water at Gravesend. The high-water level at London for the mean of the whole of these tides was 3 feet 6¼ inches higher than at Sheerness, a distance of 48 miles, with a difference of time or later high water in the Port of London of one hour and a quarter.

SHEERNESS AND LONDON TIDES.

From 1833 to 1843 low water level was comparitively the same at London and Sheerness. The present level is now undoubtedly lower at London than a corresponding tide at Sheerness amounting to from 5 to 13 inches for average springs. This difference is much greater taking single tides. The whole years' tides, one with another, show the "normal" difference at high water to be 3 feet 8 inches to 3 feet 10 inches, and low water is practically the same, or 4 to 5 inches lower in London. These differences amount to from 4 feet to 5 feet at high water and to 2 feet 6 inches for a London low water lower than the corresponding tide at Sheerness, the greatest fall at low water also amounting to 2 feet 6 inches.

The spring and neap high water differences vary from 6 feet to 2 feet. The maximum difference of range in favour of London amounts to 6 feet 7 inches, but usually 4 feet to 5 feet. The minimum high water difference is from 2 feet to 2 feet 6 inches with small neap tides, and the maximum 4 feet to 6 feet with great spring ranges, greater elevation of high water in favor of London. Exceptional tides resultant on sudden gales of wind are not taken into account.

Under exceptional conditions of weather great variations occur. On the 18th of February, 1836, with a strong north-east gale, the morning tide was only 7 inches lower at Sheerness than at London, with 14 inches fall at low water. Again on the 13th of April, 1838, the afternoon high water was only 1 foot 11 inches, lower at Sheerness than at London, where low water was 13 inches the lowest; this occurred with a strong north-west wind. These cases might be multiplied; the comparisons quoted are for the same tide at each place.

(To be Continued.)

*Without explanation, it would appear anomalous that the Elder Brethren of the Trinity House should have fixed the standard of reference for the level of low water, by a stone let into the lower wing of the Hermitage entrance, within three months after the passing of the Act for the contemplated work. The Hermitage entrance was formed on the site of an existing graving dock bearing that name, the lower wing of which (Hoare's Wharf) forms the present eastern boundary of the entrance lock forebay, and the Portland stone tablet with inscription is there now, and another above the old Shadwell entrance near the "Pelican" Stairs.

General Intelligence.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

John T. Hilton, C. E., has been appointed City Surveyor of Paterson, N. J., in place of A. A. Fonda, C. E. recently deceased.

John G. Fonda, C. E., of Carthage, Ill., will have charge of the construction of the new Southern Illinois Penitentiary, which is to be built at Chester. Operations will be commenced at once.

BRIDGES.

The new bridge over the Des Moines at Bonaparte, Van Buren county, Iowa, will be built of iron, 900 feet in length, with six spans.

The wooden bridge from Holyoke to South Hadley Falls across the Connecticut, which was built in 1870, and cost $141,000, is so shaky that it is unsafe. A good iron bridge would have been put in at the time for $160 000 by the National Bridge Company.

Two United States war vessels, the Monongahela and the Swatara, determined for themselves, week before last, how much of a bother the Brooklyn bridge will be to well-manned vessels whose top-gallant masts reach above the bridge level. The Swatara lowered her top-gallants in forty-five seconds. The Monongahela, with a raw crew, put herself in trim in one minute fifteen seconds, and after passing, was only fifteen seconds longer in raising her masts. Comparatively few vessels will have to lower their masts, and they will be but little inconvenienced. The interference of the bridge with lofty sails was one of the gravest arguments of the opponents of the structure.

GAS AND WATER-WORKS.

It is said that a Maine gas company is considering the expediency of supplying the village of West Troy, N. Y., with gas at popular rates.

Terre Haute, Ind., will hereafter be illuminated by gasoline. There are 305 gas posts in the city. The city will save $4,000 per annum by the change.

Recent improvements at the Newport, Ky., waterworks, under the direction of George W. Hornung, Superintendent, will add thirty per cent. to the pumping capacity.

The city council of Peru, Ind., are considering the plans and report for the proposed water works system, for that city, made by J. D. Cook, Esq., of Toledo, O., but had, at last advices, arrived at no definite conclusion.

Geo. C. Morgan, C. E., of this city, has been awarded the contract for constructing water works at Rochelle, Ill. There will be about 3,500 feet of cast iron pipe, which will be furnished by H.R. Smith & Co., of Columbus, Ohio.

The water works company closed a contract with the board of trustees of the village of West Troy, N. Y., on the 17th inst. for the use of eighty-five hydrants, for a term of four years from the 1st of May last, at an annual rental of $7,000 per year, payable semi-annually.

Dennis Long & Co., of Louisville, Ky., are filling a contract for about three-quarters of a mile of cast iron pipe for the extension of the Muskegon, Mich, water works, and also a contract for a considerable amount of pipe for use on the C. M. & L. S. R. R. near Muskegon.

Fourteen men are now at work improving the crib, of the Chicago water works, in Lake Michigan, with iron protections, of which quite an extended account was given in a recent number of this journal. It is expected the improvement will be completed by October 1st.

From under the bluff on which the town of Huntsville, the capital of Madison county, Alabama, is situated, bursts an immense spring, clear and cold, supplying the whole town with water for domestic uses, for watering the streets, and for use by the fire department. It is the largest spring in Alabama.

We learn from the Marion (Ind.) *Chronicle* that at a test of the water works pumping machinery of that city, on the 19th inst., a capacity was shown of raising $55,000,000 foot pounds with 100 lbs of coal, being an excess of 15,000,000 pounds over the duty called for under the contract. The machinery was built by Dean Bros., of Indianapolis.

The recent experiments made in Paris with the "Candle Jablochkoff" have proved so successful that owners of gas stock may become alarmed, for it is claimed that a substitute for gas may be procured, which, under the most favorable conditions, will be three times cheaper than gas. It is adapted to indoors and outdoors, is inexplosive, odorless, without flicker and preserves the original color of the articles which it illuminates. It in no way resembles any of the electric lights previously introduced, and its cost is said to be reduced to one-fifteenth of the cost of gas in manufactories having hydraulic power. The candle used lasts an hour or two, and is replaced by an automatic arrangement, thus securing light for any length of time desired.

RAILROADS.

Jamestown, N. Y., talks of building a street railway.

Fulton county, Ill., owes $105,000 railroad debt.

The three street-car lines, of Burlington, Iowa, are to be run as one.

A railway car for the royal family of Norway, has just been built in Philadelphia.

The Mammoth caves of Kentucky are to be connected with the outer world by a railroad.

The great railway wharf at St. John, N. B., is being rapidly constructed at a contract-cost of $1,774,000.

The people of Lincoln county, Wis, are agitating the subject of building a railroad from Wausau to Jenny, on their own account.

The Cheram & Chester Railway Co., (narrow gauge) of South Carolina, have five miles of track laid and are pushing forward with the work. R. J. Latta is the Chief Engineer of the road, with headquarters at Chester.

Paper wheels are now being tested under one of the heaviest locomotives running over the Philadelphia, Wilmington and Baltimore R. R. They have been running now for some weeks, and have thus far proved highly satisfactory.

It is said to be authoritatively stated that the principal shops of the Union Pacific R.R. are to be removed from Omaha to some point towards the western end of the road. It is suspected the new site will be convenient to the company's coal field.

The Wason Manufacturing Company, at Springfield, Mass., recently sent 50 car wheels to the Grand Trunk R. R. as a sample of their work, and shortly an order came back for 1500 of the same sort. They are also at work on a lot of hay-cars for another road

Metallic sleepers are now expected to make rapid progress in Belgium; the employment of them had been long since decided on, and everything seems to in-

dicate that the state engineers have now recognized the indispensable necessity of them.

The slipping of the wheels of locomotives is almost nothing when going up a grade, but in descending it is very great and it increases, whether on an up or down grade, in a certain proportion to the speed. Such, at least, is the result of the observation of M. Rabeuf, of the Academy of Sciences, Paris.

A well attended meeting of promoters of the project of building a narrow-gauge railway from Delphos, O., through the Laramie and the Stillwater valleys, to Dayton, to intersect the Dayton & Southeastern narrow-gauge R. R., at Covington, Miami County, was held in Dayton, on the 18th inst.

In compliance with the requirements of the late Legislature of Kansas, returns have been made to the State Auditor showing that the railroad debt of 66 of the counties of the State amount to $12,595,000. The returns from the other counties will increase this sum to abont $15,000,000. The total taxable wealth of the State is $150,000,000.

The Erie railway company is about to build six new locomotives at its shops in Susquehanna, Pa. They will be narrow gauge engines, and without the tender will weigh fifty tons each. They will have four drivers, connected on the side, and also a four-wheeled truck. Size of cylinder 20 by 24. They are expected to pull forty narrow guage cars. The first one will be completed about November first.

A table of statistics recently published, shows that on English railways the proportion of passengers killed is one to every 17,000,000 carried; number killed or injured, one to every 488,908 carried; number of employés killed, one to every 416; number of employés killed or injured, one to every 86. In Massachusetts, the same table shows one passenger killed to every 35,000,000 carried; one killed or injured to every 8,750,000 carried; one employé killed to every 650. and one killed or injured to every 304.

MISCELLANEOUS.

A telephone is in operation between Binghamton, N. Y., and Scranton, Pa.

The question of building a $75,000 Court House is to be submitted to a vote of the people of Mahaska county, Iowa.

The water committee of Montreal, has decided not to allow any volunteer fire company to draw water from the city hydrants.

A new line of steamships will be placed upon the route between New York and Venezuela, South America, early next month.

The inhabitants of Kalamazoo, Mich., pride themselves on its being the largest village in the State, and will not hear of a municipal government.

An attempt is being made to open communication with the interior of Ecuador by way of the River Putumogo, or Ica, leading into the Amazon.

A survey of the State of New York is now being made by triangulation, and signal-poles, capped with tin reflectors mark the stations on the highest hills.

The Oneida Lake canal, in New York State, will be open for navigation shortly. It will afford direct water communication between Oneida and Oswego.

The Government of Turkey has never made a topographical survey of its dominions in Europe; hence the maps of the country have been constructed upon the materials gathered by foreign and independent explorers in isolated districts, and are naturally defective.

It is asserted that the Portuguese African exploration expedition, under the direction of Major Pinto and Captain Capello, which has left for Loando, is the best that has ever been organized, from a scientific point of view, and most valuable results are expected from it.

An Arctic expedition will probably be sent out by the Dutch, under the command of a Dutch lieutenant who has made three Arctic voyages under the British flag. Its object is not the discovery of the Pole, but the erection of granite monuments to some of the early Dutch voyagers.

The party of Frenchmen who settled on the east coast of Sumatra in 1876, have prospered in their enterprise, and M. Lias, the leader of the expedition, has returned to France to organize a second band of emigrants. He brought with him several rare animals, which he has presented to the Jardin des Plantes.

A rapid sketch-survey of Brazil is to be made under the direction of Field-Marshal H. de Beaurepaire-Rohan. This is all that is at present possible with the small staff at command exploring a country of the vast size and thin population of Brazil. It has been calculated that it would require eight centuries to execute a map of Brazil after the manner of the topographical map of France.

Paterson, N. J., is paying a considerable degree of attention to sewerage. Contracts were awarded last week for about 3500 feet of new sewers, cement pipe being ordered to be used, except where brick sewers were called for by the proposals, it being manufactured in that city and former experience having demonstrated it to be entirely satisfactory and durable. We note the statement that the receiving basins used, which are of the Jersey City pattern with granite head, were awarded at $83 each, while three years ago the city paid $160 each for the same article.

The Pittsburgh (Pa.) *Dispatch* says: "The duration of wooden pavements, at least of the Nicholson and Miller type, appears to be about seven years under the regular city travel. This was demonstrated in the case of Fifth avenue and Wood street, and now finds further instance on Penn avenue, in the old Lawrenceville district. It was represented by the patentees and agents of these pavements that they would outlive the recollection of the oldest inhabitant—but the fact is they do not run quite as long as the bonds issued for their construction."

Some idea of the rapid and gigantic growth of the British metropolis may be gained from the statistics recently furnished by Colonel Henderson, commissioner of the London metropolitan police. He says that during the past year 226 new streets and three new squares have been opened and handed over to the police. They extend over 36 miles, 1,074 yards. Twelve thousand nine hundred and thirty-eight new houses were built during the year, and 4,151 were in course of erection; a considerable increase above previous years. One thousand two hundred and forty-seven miles of new streets have been opened in London since 1850, and there seems no tendency to decrease in the annual rate of progression. This increase is accompanied by a similiar increase in population, whose necessities for locomotion must be proportionately augmented. As a consequence the slaughter in the streets in one year resembles that of the losses of an army in some small South-American Republic. Colonel Henderson adds, that 3,303 persons, suffering from accidents or other causes, were conveyed to hospitals by the police. Quite 130 were killed, and 2,740 were maimed in the streets during the year by cabs, omnibuses, light carts, broughams, vans, etc.

State Engineer Van Buren has recently made an inspection of the western division of the New York State canals. The general conditions of the Erie is excellent. At a few points the high banks require strengthening, and one or two bridges and a few of the smaller structures repairing or rebuilding. There is great activity along the whole line; the canal is alive with boats.

The immense stones used in the erection of the Pyramids of Egypt were obtained from the quarries in the Arabian hills, and were carried to the river and over a bridge of boats. They were then brought forward by means of a causeway, which is said to have been a fine work, with its polished stones and figures of animals engraved upon them. One hundred thousand men were employed at a time, and these were relieved by the same number at the end of three months. A long time was spent in the leveling of the rock on which the edifice stands, and twenty years for the erection of the pyramid itself. The stones were raised step by step by means of a machine made of short pieces of wood, and, last of all, commencing from the top, the stones were cemented together with a layer of cement not thicker than a piece of paper, the strength of which is proved by the age of these enormous memorials.

The final close of operations in hydrography and topography of the United States lake survey was effected on the 20th inst. The three shore parties under Assistant-Engineers F. M. Tonar, F. Terry, and A. C. Lamson were conveyed to Detroit, the headquarters, by the United States steamship Ada, in command of Lieut. P. M. Price. The off-shore hydrography was carried on during the greater part of the season by Lieut. D. W. Lockwood, but, being called away to another post of duty, the completion of the work was left in charge of Lieut. Price. To Assistant-Engineer F. M. Tonar was given the topography and inshore hydrography of the islands, sixteen in number, about Put-in-Bay, Ohio, the Bay of Maumee, and a portion of the Canada shore from the mouth of Detroit River eastward to Little's Point, and the eastern extremity of operations at Point au Pelee. Assistants Terry and Lamson were given Kelly's and Point Pelee Islands, Toledo, and shore line intermediate with Tonar's. The primary triangulation under Assistant-Engineer J. H. Dowell will be completed next month. The chart of Lake Erie will be published within a year, which, with the charts of the other lakes, will end the so-called survey of the Northern and Northwestern lakes, for at least half a century. The estimated cost for the forty years' labor is not far from $2,000,000. For some years past this and many other surveys have been in charge of Gen. C. B. Comstock. The General is allowed one month's vacation each year, but, having taken no vacation for twelve years past, he is now abroad, at liberty for one year. Capt. H. M. Adams is in charge during his absence. Immediately upon the close of the lake survey, Lieuts. Lockwood and C. F. Powell, with assistants F. Terry and A. T. Morrow, and others, were ordered to Memphis to continue the survey of the Mississippi River.

A NEW SEWER TRAP.

The illustration below and the text accompanying it will make our readers acquainted with Wm. Kirk & Co.'s, of Philadelphia, new sewer and drain trap. We cannot speak from experience upon the many varieties of traps recently invented, and which the increasing interest in sanitary affairs continues to call forth, but that there is room for improvement in many of the popular forms in use is evident, and any promising addition to the list of new inventions in the line of traps or valves, so important a feature in a good drainage system, is well worth attention.

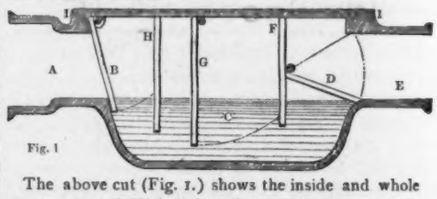


Fig. 1

The above cut (Fig. 1.) shows the inside and whole construction of Kirk & Co.'s Sewer Gas Trap. A is the end next the house which is intended to be kept clear of gas. B is a seated valve hinged above, which opens as the flow from the house presses against it. C is the water trap which remains always in the trap and shows the high-water mark. D is a valve or tongue which rises and lets the water and soil out into the pipe E. F is a fixed seal which extends all across the box inside—this with the valve D renders it impossible for the gas to enter the trap, much less get up into the house. When there is a great flow through the pipes, the mouth of the pipe E is full, as also the pipe below, which forces out the air, leaving very often a vacuum, and the ordinary trap is rendered useless by the water being all drawn out of the trap, and allowing the gas unchecked to pass into the dwelling.

To prevent this untrapping, there is a hinged seal G which moves forward as the water is being drawn out and allows the air to pass under seal F and through valve D, filling the vacuum, when swing-seal G immediately falls back to its place, still trapping it. There are some pipes in use with a valve, but as soon as the water opens it to pass out, there is a space all around through which the gas passes up unchecked; but in this there is no gas present in the chamber formed by seal H into which the valve B opens, and therefore none can pass up. Both of these valves B and D act in keeping any overflow or back pressure from the sewer. The top plate II is screwed down and can be removed at any time.

This Trap can be attached to, or inserted into, drain pipes in the yard or cellar at any time, with very little trouble or expense.

SHALL THE U. S. TESTING BOARD CEASE TO EXIST BEFORE ITS WORK IS HALF DONE?

In a statement to the American Society of Civil Engineers, made by the Secretary of the "Board to Test American Iron, Steel and other Metals," on March 7th, 1877, the following facts were presented which are surely of the deepest interest not only to the civil engineers and architects of the country, but to all who make use, buy or sell the metals which we as a nation produce:

We have been for years importing cast iron from abroad while we have domestic products of equal and even greater intrinsic value selling in our markets at lower price. We are importing boiler plate at 11 cents a pound when we can purchase American steel, vastly superior in all respects for the special purposes to which the former is applied, at 8 cents. We import vast quantities of foreign steel tools, when, at Pittsburgh and elsewhere, we make steel fully its equal. In New England and Pennsylvania we have ores from which are made the finest cast-iron ordnance in the world. In Ohio, we make a metal for car-wheels such as never is seen in Europe, and of such tenacity and elasticity that foreign engineers listen incredulously when it is described. Our Lake Champlain ores make an iron equal to even Swedish for conversion into steel, and around Lake Superior and Missouri we have deposits from which come Bessemer metal vastly superior to the phosphorus-charged metal imported. New Jersey supplies us with zinc which meets with no competition as a pure metal and which can be used without purification for even chemical purposes; and our native copper is, as I know by experiment, absolutely free from admixture with injurious elements.

Yet, notwithstanding the fact that we possess the purest and best ores and make the best metals, we continue purchasing abroad. This fact arises: *first*, from a natural conservatism which induces us to continue to pursue a course to which we have been accustomed even after we knew it to be an improper one; *second*, partly from that unfortunate American habit of self-depreciation which assumes, whatever comes from abroad to be, from that fact, superior to the product of our own country and of our own industry; and *third*, from the fact that our own people do not know and cannot readily be made to believe that our own materials are so excellent.

It was to meet the last difficulty, partly, that this Board was proposed. No private individual can afford to attempt the systematic and only truly economical methods of development of these facts, and no one has interest so general as to make it imperative that he should do so, were it in his power. Even were the work done, and well done, by a combination of private interests, it would s ill have comparatively little value, as the public invariably looks with distrust upon all statements made by private individuals, and suspects that private interests may have given tone to their reports. The maker of the very best iron, or of the best possible steel, cannot prove beyond cavil that his product is better than any similar metal purchased abroad. Only the general government can institute an investigation that shall cover the whole field, that shall be systematic and scientifically thorough and of which the reported results shall be accepted without distrust.

The s cond of the two classes of necessities leading to the creation of the Board was felt most keenly by our engineers and constructors, and by our manufacturers of machinery and of parts of structures. They knew comparatively little of the strength of our metals in small parts, and were still more seriously ignorant of the effect of making up any material in large sections and into the heavy members of bridges and other structures. They could not predicate dimensions on well ascertained measures of the strength of our iron, and were ignorant of the loads which could be sustained by heavy beams, girders, and columns made of this or of any other metals.

For years, they had been compelled to base their calculations on tables of strength of materials furnished by foreign experimenters, as Hodgkinson, Tredgold, Barlow, Morin, Rondelet and Muschenbroeck, who gave the results of experiments on Carron iron and other metals, whose names were strange to American engineers, and which our builders never use. Recently Kirkaldy, Styffe and some German experimenters have given us valuable information, but nothing of any considerable value has been published in reference to our domestic materials.

These facts and many more which the speaker had not time to consider, led to the appointment by the Society, several years ago, of a committee to secure the inauguration of scientific and exhaustive examination of our American materials by a Government commission. This committee sent a delegation of its own members, and of other members of the Society before the House Committee on Appropriations, in the spring of 1875, and secured the modification of a bill already in committee, which had originated with the Architect of the Treasury, and its adaptation to the plan proposed. Under the provisions of a bill thus secured from Congress, the President appointed a commission, consisting of two army and two navy officers and three experts from civil life; and this Board was organized and immediately adopted a very comprehensive plan of research, which was reported to the Society a year ago. Committees appointed to carry out the investigations proposed, issued circulars, which were published in all scientific and engineering periodicals, as well as in the Transactions of the Society, and which detailed these plans of work and asked advice and information. These circulars brought out very little useful material.

The Board contracted for a large testing machine, combining the plans of Messrs. Albert H. Emery and Charles E. Emery—the latter a Member of this Society—which machine was expected to have been long ago completed, but is not yet ready for work. It was intended to test large pieces, as heavy beams, girders, and columns.

While awaiting the completion of the machine, the Committees of the Board conducted their special investigations, where they could do so without the use of the large machine, making use of such other machines as were available.

Some of the Committees have reports, either completed or in progress. The Committee on Wrought Iron had finished several investigations of the methods of making iron, on the effect of impact on metal, on the effect of various strains, &c., &c. The Committee on Chain Cables has been studying the methods and material of cable manufacture. The Committee on Tool Steel had completed a series of tests of the value of steels for cutting tools; analysing them to determine their composition, and breaking them to ascertain their mechanical properties. The report is in preparation. The Committee on Abrasion and Wear had completed that portion of its work formerly reported as in progress. The Committee on Metallic Alloys has determined the tenacity and other forms of resistance of all copper-tin alloys, their ductility, resilience, density, &c.; and the report is complete and in the hands of the copyist. A similar series of tests of copper-zinc alloys has been completed, and the report is in preparation; and an investigation of the properties of triple alloys of copper, tin, and zinc is in progress. The speaker described the methods of research adopted and indicated the general nature of results attained. The Committee on the Effects of Temperature has collected a large quantity of materials for test, and is still getting samples. The investigation is planned, but not yet commenced.

The Committee on Beams, Girders, and Columns, has made a valuable set of tests of rolled wrought iron beams of various sizes by the use of dead loads, and procured a large quantity of beams and columns of the forms and sizes in common use in buildings and bridges for test by the testing machine when it is ready for use.

As just indicated, the Board has been working steadily for two years while awaiting the construction of its testing-machine—has done a large amount of work, and has completed, or has in preparation, some extended and probably valuable reports.

The speaker stated that reports of progress had been made to the President, and that, a year ago, Congress had been requested to make an appropriation to enable the Board to continue its work, and to do some heavy work with its testing machine. The appropriation was granted by the Senate, but defeated by the House Committee. The same experience has been met with during the session just closed. No opposition had been met with either in the Senate or on the floor of the House, and every well known member of either party, and especially those of recognized intelligence and standing, had taken real interest in the matter. The House Committee, with but one or two exceptions, had, however, determinedly refused, and had even inserted a provision in the Sundry Civil Bill of 1876-7, extinguishing the Board, when the money in hand should have been expended. That provision remains a law. The oppropriation in hand will be expended during the coming year, 1877-8, and this Board, which had been procured and sustained by such earnest action, and so great an amount of hard work on the part of members of the Society, will be disbanded just as its plans and methods are thoroughly settled, and are bringing forth abundant fruit, and just as it is ready to undertake the most important of its researches—that on large parts of structures.

It is possible that earnest and determined action may preserve it, but it can only be done by taking steps as will convince the members of the House Committee on Appropriations of the next Congress:

1st. That this work is of national importance in developing our mineral resources and manufacturing industries and in securing safety of all large constructions; that it is an absolute necessity.

2d. That no individual can do such work, and that no combination of private individuals can make a complete and satisfactory investigation, even were the results of such work likely to be accepted as authoritative as would be the right of a Government commission.

3d. That, while this work is as appropriately a matter of general legislation as the support of the Patent office, the Department of Agriculture, or of topographical and hydrographical surveys, it will secure returns of incalculable value, with insignificant expenditure.

If members of the House Committee can be shown these facts, the Board may possibly be continued; but it will only be by such convincing evidence as will fully controvert their pre-existing ideas, and convert them to a broader and more liberal faith. The Board has been formrlly endorsed by this Society, by the American Institute of Mining Engineers, the Iron and Steel Association, by all the technical schools, and by other institutions of learning, and has kept the members of the committees informed of the progress of its work. It has not been successful in securing proper recognition, notwithstanding all this and notwithsanding the efforts of prominent men of both parties in Congress. It has done all that it, in propriety, can do, and will probably now simply present its reports on Committee work, state its readiness to go on with the greater work assigned it and leave the matter to be decided as shall be determined by the House Committee on Appropriations, in the light of such evidence as they may thus be given. There is imminent danger that the Board will be discharged before it can report on the strength of a single 15-inch beam, or determine a single law relative to the resistances, of parts of structures. It has, however, accepted its duties, and has undertaken them in good faith. Its members have discharged their duty faithfully, so far as they have been permitted, and have devoted, voluntarily, a vast amount of time to special research without compensation, and their only regret will arise from a natural reluctance to see their work interrupted, just when most certain to prove useful, and from the disappointment which, in common with all interested in the movement, they must feel at this premature interruption of a great and needed work.

The railroad men of the country should take an active and special interest in the success of this effort to procure the knowledge necessary to a correct application of the metals to railroad purposes.

And if they and all the engineers, architects, and iron and steel makers and workers of the country, will come up at once to the support of the Board with all the influence they can exert upon Congress in favor of the small appropriations that will be necessary to carry forward the work of the Board to completion, Congress can surely be induced to apply a small portion of the public treasure to procuring knowledge that will be so conducive to the public interest.

ERRATA.—In the recent articles on the "Metric Discussion" we call the attention of our readers to the following corrections: In the 8th line of article I. a period should be inserted after *there is no denying that.* In the 32d line from the end of article I. *grains* should read *grammes.* On page 250, in the 2d article, in the 35th line from the top of the column, the word *adopted* should read *dropped.*

REPORT ON VARIOUS METHODS OF CONSOLIDATING EARTH THAT HAS SLIPPED.

BY M. COMOY,

Inspector General (Retired) of Ponts et Chaussees.

Translated for ENGINEERING NEWS by Brevet Col. Wm. E. MERRILL, U. S. A.

(*Continued from page 267.*)

6th.—Slips of the slopes of the embankment of the Cercey reservoir of the Burgundy canal.

The embankment of the Cercey reservoir of the Burgundy canal was built of argillaceous earth of the Lias formation, with an interior slope of 1 vertical to 2.4 base, and an exterior slope of 1 vertical to 2 base.

The length of the dam is 3280 feet, and the depth of water in the reservoir is 40 feet.

Many slides have taken place on the two slopes of this embankment.

But we must first speak of the repairs of the exterior slope, which for the most part preceded those of the interior slope, and besides were designed with the same view.

The slips of the exterior slope, seven in number, took place between 1835 and 1846.

All of these slips were repaired in the following manner: The whole mass of moving earth was removed down to the bed on which the slip occurred. On this surface thus laid bare and cut into steps, partition walls of dry stone were built at right angles to the axis of the dam, the distance between them being from 25 to 30 feet, and their tops being made to conform to the slope of the embankment. The spaces between the partition walls were filled with thoroughly rammed earth, thus restoring the embankment to its original shape.

These repairs have given good results. Only one accident has since happened in that part of the exterior slope which was repaired.

In this method of repairs the partition walls of dry

stone serve both to divide the sliding mass, so as to localize the movements, and to drain the embankment. To make the drainage more effectual these walls are made to rest on a masonry culvert which carries out the water without permitting it to flow over the earth of the fill and disintegrate it.

The following is what happened to the interior slope:

In 1842 a slip took place in the interior slope of the embankment, to the right of the emptying culvert. It was repaired by means of eight partition walls of dry stone built just like the partition walls of the outer slope.

It is necessary to state here that the filling of the embankment was not all done in the same way. The interior slope was puddled for a depth of 24 feet at the bottom and 13 feet at top, whilst the core of the embankment was simply rammed and compressed by the passage of vehicles. This is the way in which the engineers in their reports describe the method of raising the embankment.

The inconveniences which might result from this lack of homogeneity were not overlooked while the repairs of the accident of 1842 were in progress. The engineers deliberated over the consequences which might take place from the introduction by the blind drains of the water of the reservoir into the interior of the embankment, and up to the very core itself, which latter had been cut by the curve of the surface of sliding. However, as this core appeared solid and entirely impermeable, they concluded to adhere to the mode of repair that had succeeded with the exterior slope.

Experience at first appeared to confirm the anticipation; and during nearly twenty-five years the portion of the interior slope thus repaired experienced no movement.

But in the month of September, 1866, after three days of torrential rains, although there was then 30 feet of water in the reservoir, new slips took place in the same part of the interior slope, to the right and the left of the slip of 1842, and partly along the line of the slip. Moreover, along the whole distance affected by the slips of 1866 and 1842, the interior revetment of dam showed irregularities that caused a belief that the entire mass overthrown in 1842 had shared in the movement of 1866.

In consequence it was resolved to repair the interior slope along the whole length affected by the slides of 1866 and 1842—that is to say, along a length of 650 feet.

The method of repair actually adopted consisted, like that used on the outer slope, in constructing partition walls at right angles to the axis of the dam, resting on steps cut into the surface of slipping earth, but with this difference, that instead of being of dry stone the partition walls were built of hydraulic mortar.

These walls are 6½ feet thick, and are distant apart about 40 feet.

They are connected at the foot of the slope by a retaining wall having a height of from 7½ to 10½ feet, and a thickness of from 7 to 10 feet.

All the earth affected by the slipping was removed, and afterwards replaced between the counterforts, according to the profile of the embankment, and thoroughly rammed.

The interior slope thus reconstructed was covered with a paving of stone 15 inches thick set in dydraulic mortar.

The surplus earth was placed against the retaining wall to which it answered as a backing.

The partition walls are supplied on their two faces with two or three vertical counterforts 40 inches wide and projecting 40 inches, designed to hold back earth which might still have a tendency to slip.

The two partition walls which surrounded the emptying culvert are connected by an ogive arch normal to the surface of the slope. Similar arches had been designed between the other partitions, but in execution they were suppressed.

The cost of these works of repair is estimated at $26 000; which, for the 650 feet in length of dam to be repaired, would make cost $40 per running foot.

Six partition walls have already been built; three to the right and three to the left of the emptying culvert. They embrace a large portion of the slip which took place near this culvert.

No new movement has appeared in the portion of the dam thus repaired. The revetment only shows the wear on the surface caused by the beating of the waters.

7th.—Slips of the interior slope of the embankment of the Torcy reservoir of the Central canal.

In 1831 the dry stone paving which protected the interior slope of the embankment of the Torcy reservoir on the Central canal slid down along almost its whole length. In addition, the earth of the embankment slipped at several points. The most important of these slips was situated to the left of the bottom culvert.

The embankment of the Torcy reservoir has a length of 830 feet, and it holds a depth of water of 36 feet. The two slopes have an inclination of 1 vertical to 1½ base.

This embankment was constructed of sandy earth mixed with a certain quantity of clay. The works of repair have shown the presence of several veins of earth in which clay predominated.

The fall of the paving undoubtedly resulted from the fact that the earth composing the dam, at least at certain points, contained too large a proportion of clay, and probably also from the fact that the ramming of this earth was not done with the requisite care and energy.

However that may be the accident happened, and we found ourselves thus deprived of the Torcy reservoir, at the same time that another of the large reservoirs of the Central canal, the Berthaud pond, was already out of use.

Under these circumstances it was not practicable to attempt the thorough reconstruction of the somewhat inferior filling of the Torcy embankment, which would have been necessary in order to obtain a solid construction. It was obligatory to act quickly, and it was dedecided to build a new revetment of the interior slope without doing anything to the embankment of the dam except to reconstruct the portions of the slope that had slipped. In the heaviest slips the one to the left of the bottom culvert, these cuts were made normal to the slope and descending to the bed on which the slipping occurred. These cuts were filled with earth thoroughly worked and rammed.

By these means the Torcy reservoir was speedily repaired and its water was available for navigation from and after the following year.

But the repairs were certainly incomplete. The inferior quality of the embankment of the dam rendered new movements inevitable; and it was not long before these made their appearance.

In the movements that took place on both sides of the bottom culvert, but to a more marked degree on the right than on the left, the crests of the different retaining walls were depressed and at the same time they pushed towards the interior of the reservoir.

It became evident that a slip was starting in the interior of the embankment.

This time also the authorities shrank from the loss of time which would have occurred had the whole embankment been reconstructed in a suitable manner, which reconstruction would have been necessary, in view of the inferior quality of the core of the dam, in order to seat the revetment solidly on the fill.

Moreover the entire reconstruction of the embankment would have caused a considerable expenditure.

Under these circumstances, and for double reasons of rapidity of execution and economy, an effort was made to be independent of the bad quality of the embankment by constructing a certain number of partition walls, or interior counterforts, at right angles to the axis of the dam, and resting on the solid natural soil. These counterforts were to lessen the chances of slipping and to secure solid points on which to support the masonry of the revetment.

The counterforts were made so numerous that in the spaces between them the revetment of the slope would be able to resist the distortions which might be produced by the settlement of the embankment.

To make the work more rapid and less costly the counterforts were made of piers connected by arches.

In accordance with the arrangements adopted the piers of the counterforts, which became the fixed points of the system, were brought nearer together as the height of the embankment increased.

I gave a detailed description of the works and of their method of construction in an article inserted in the *Annales des Ponts et Chaussees* for May and June, 1845.

At first only the portion of the embankment to the right of the bottom culvert, in which there was the greatest movement of the retaining walls of the interior slope, was repaired on this system. This was done in 1838.

Later, in 1845, the movement having become more marked in the portion to the left of the bottom culvert, it was treated in the same way.

In both of these repairings the revetment walls of the interior slope were entirely rebuilt in accordance with the regular profile of the embankment.

The success was complete. Since these repairs were made no movement has appeared in the interior slope of the Torcy dam.

The expenditures amounted to $5,555 in 1838, and $5,995 in 1845; a total sum of $11,550. The length of dam repaired being 830 feet, these works have cost $14 per running foot.

CHAPTER II.

OBSERVATIONS UPON THE WORKS DESCRIBED IN THE PRECEDING CHAPTER—PRACTICAL RULES TO BE DEDUCED.

Thus far I have made no distinction between the different slips which I have described.

But I will here remark that accidents to the embankments of reservoirs are exceptionally serious. In the first place navigation is greatly interested in them. In addition the rupture of reservoir embankments has such disastrous consequences that it is of the greatest importance to remove all chance of such accidents.

For these reasons in the remainder of this article I will treat separately the questions that relate to reservoir embankments.

In the first place I will present some general observations upon land slides, their causes and their characteristics.

1st.—General observations on the sliding of argillaceous soils.

The opinions of engineers at different periods have often varied as to the causes of land slides, their manner of production, and the means of stopping them.

I have no intention to enter upon these historic details, and the best thing that I can do is to send engineers who may desire to know them to the interesting work published in 1846 by my comrade, M. Collin, entitled "Experimental Researches on the Spontaneous Sliding of Clayey soils."

From previous investigations on this subject I will only extract the following proposition, which is self-evident.

Earth lying on a slope commences to slip when the force of cohesion which retains it on a given inclination diminishes from any cause and becomes more feeble than the action of the weight.

The chief cause of the change in the force of cohesion of earth is the accidental presence of water within it.

Slips have been observed in all seasons, in summer as well as in winter. But almost all the slips of summer have occurred after heavy rains.

The force of cohesion of earth being thus changed, the following indicates how the slipping occurs that is caused by this change:

If a transverse cut be made into earth that has slipped we discover that the slipping has taken place on a curved bed, smooth and apparently soapy, which is nearly vertical at the top and almost always becomes horizontal at the bottom. M. Collin has determined the exact form of a great number of these curves of sliding, and has shown that, as a rule, they differ very little from the cycloid.

Moreover, when slipping earth separates from the solid mass, it marks out on the slope a curve of variable extent which is convex at the top and gradually descends to the foot of the slope at its two extremities.

These principal characteristics are found in all slips except in rare cases due to very special circumstances, as for example to the presence of strata of rock under the slipping mass.

From the constant existence of the inner soapy surface on which slipping occurs, several engineers have concluded that before the accident there was a fissure in the soil having the shape of the observed bed. In

their opinion sliding was the consequence of the introduction of water into this pre existing curved fissure.

M. Collin opposed this view, and very justly. He has shown very clearly that the soapy surface of sliding is the effect and not the cause of the slide.

Sliding does not take place on a natural surface except when the sliding mass comes to a stratum of rock inclined in the direction of the movement of the soil. When the stratum of rock is not carried along, sliding takes place on it, and it is thus that the earth of the hillside of the right bank of the Allier slipped, as I have mentioned in the preceding chapter.

But outside of this exceptional case, whenever slips take place in more or less homogeneous masses of argillaceous soil, the soapy surfaces, whose presence is always reported, are unquestionably the result of the slipping itself.

If the surfaces of slipping were determined by pre-existing fissures, due to causes foreign to the slipping and necessarily of various origins, the variety of these causes unquestionably would not agree with the permanence of the general characteristics presented by all surfaces of slipping.

On the other hand, the curvature common to these surfaces is very well accounted for by admitting that they are formed at the moment when the mass of softened earth separates from the mass that remains solid.

When a mass of earth thus modified is no longer kept in place by the force of cohesion with the adjoining earth, it has a natural tendency to fall. But it finds more solid strata below it which stops it from falling. It must then necessarily turn and push in the direction where there is no resistance. In this movement it drags with it, in virtue of the power given by its mass and its velocity, some portion of the earth under it which is less softened, or may even be firm, and thus gives rise to the regular cycloidal curve which is observed.

Under this hypothesis it is equally easy to explain the shape of the curve on the surface, which is the boundary between the earth that slips and that which remains fast.

In fact, let us admit, for a moment, that the strata of earth, cut out at right angles to the slope, which lies just in front of the point where softening, the cause of slipping, has taken place, is independent of the adjoining unsoftened slices. This slice will slide by itself, following the cycloidal curve indicated above. But the softened slice adheres to the adjoining slices, and drags them along with it. The adjoining slices in their turn drag along the next ones, and thus it continues.

However, the dragging of the slices adjoining the softened slice is not effected without a certain loss of force. These adjoining slices must be detached from the mass of earth which does not share in the movement, and the force due to the fall of the central slice is partly used to effect the separations of these slices. The latter, therefore, have less power to drag along the slices that adjoin them than was exercised on them by the central slice. The dragging power of the successive slices on the slices that adjoin them continually diminishes as we get away from the central softening, and it finally becomes null.

The different slices dragged along in succession are thus shorter and shorter as they increase in distance from the softened central slice. Consequently they ought to leave on the slope the curved boundary line, convex at the top, which is always found.

We must then conclude with M. Collin that the curved surface of sliding resembling a cycloid and making on the surface of the slope a curve convex at its top, which is found in all slides, is the result of the slide itself; that it is produced by the forces which are developed by the modification of a portion of the earth, and by the cohesion which still remains in this modified earth.

It follows from what precedes that a loss of cohesion taking place at any point in a mass of argillaceous earth is sufficient to cause a slide having a length much greater than that of the modified earth.

This is also in conformity with observed facts.

When a slip is thus caused by modification at a single point the curve which it marks on the slope is very nearly an arc of a circle whose chord is large or small according to the degree of resistance which the sound earth adjoining the modified earth makes to being dragged along.

When earth is modified at several points sufficiently near each other, the different slips unite and form a single elongated slip, but its curve always descends at its extremities, and has two convex half curves at its top.

I have expatiated with considerable detail on the circumstances which accompany slips and determine their form, because, as will be seen further on these circumstances have a very important part in the question of the means to be used to stop land slides and to prevent their re-appearance.

(*To be Continued*).

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society; Associate of the Institution of Civil Engineers.

By work tests is meant tapping the plates with a hammer to ascertain if they are solid, in which case each tap will produce a ringing sound. Breaking the corner off a plate here and there. [of course before the plates are "worked."] and examining the punchings from the iron, for the purpose of forming some idea of its quality. The punchings from Low Moor and some of the Staffordshire brands will stand the punch without the slightest sign of cracking, whilst hard, brittle iron will break up in all directions on the convex side of the punching. Good ordinary iron, such as ought to be used in girder work, will only show slight cracks, all running with the fibre of the iron.

It may be said that the condition of the punchings depends very much on the relative size of the punch and die. This is true, but for various reasons in ordinary working there is always a little clearance.

There are several other tests which are sometimes carried out, such as hot and cold forge tests, but these are at the best uncertain, depending very much on the man who makes them. A good smith with a small hammer will bend a plate to a much greater angle than another smith with a large hammer, and one smith will bend a given plate to a greater angle than another can do.

Resource to the hot forge tests is usually had to detect red or hot short iron, but if a competent inspector be employed to supervise the work he will detect this in the working of the iron. If the red shortness is so slight as to escape detection in this way, it need cause no uneasiness, as after the portions are shaped and the iron is cold, it is not detrimental to girder work. Besides, so long as the engineer protects himself against cold short iron by the tests previously mentioned, he may leave the matter of red shortness to the contractors and ironmasters, as it is to both of their interests to provide against this defect. If the iron will not work into the required forms, the contractor returns the iron on the hands of the ironmaster, who perhaps loses a good customer.

Although a tensile strength of rivet iron has been given, it usually happens that the rivets are not manufactured at the contractor's works, and so the rivets are more often tested by forge tests, both hot and cold, as it is absolutely necessary that they should be neither hot nor cold short.

A good rivet may be bent double whilst cold without showing any signs of fracture, and the head when hot should stand being hammered down to less than ⅛ in. in thickness without cracking at the edge. They should also stand having a punch of nearly their own diameter driven right through the shank of the rivet when hot without cracking the iron round the hole.

Lord Ward's and Galloway's rivets will stand these tests satisfactorily.

The texture of the rivet, if nicked and bent gradually, should be fine, fibrous, and silky; if nicked all round and broken by a smart blow, the fracture should exhibit a fine, even, crystalline appearance.

It is almost needless to point out that when iron is broken suddenly the fracture invariably presents a crystalline appearance, and that when the strain is gradually applied the fibrous fracture always results if the iron is soft, tenacious, and otherwise of good quality; but it is the generally accepted opinion that with really bad iron the fibrous fracture cannot be obtained by any mode of testing.

Whether the iron is fibrous or crystalline its quality may to some extent be determined by its texture. If good iron, it will be fine and uniformly close grained, of a silvery grey color; if of a very inferior quality it will present a coarse granular fracture, having more of the color and appearance of cast iron.

The test for tensile strength and toughness should be carried out by independent authorities such as Mr. Kirkaldy, of the Grove Testing Works, Southwark, and the Superintendent of the Birkenhead Chain and Anchor Testing works, belonging to the Mersey Docks and Harbor Board, at which latter establishment is to be found about the finest testing machinery in the world. An engineer proceeding to the contractor's works to test materials is quite unable to state with confidence that he has obtained accurate results without measuring the levers or diameter of the rams as the case may be, and going into a series of minute calculations to check the accuracy of the machines. This, few men have the strength of mind to do in the face of repeated assurances on the part of the contractor's men that everything is all right. Ordinary experience, however, teaches that a man is perfectly justified in making such investigations. Who has not, after one of these periodical inspections, happened to catch a knowing wink intended for other eyes, but nevertheless conveying in very plain terms the impression that something has not been quite square, and that after all one has been done somehow? This is annoying when an engineer has gone through no little amount of heartburning for the sake of carrying through his investigations as a matter of duty. Even although the calculations prove the testing of machinery to be at fault, nine out of ten men will be constrained to pocket their papers and proceed with the testing, thinking that in the hurry and confusion a slip must have been made somewhere, either in taking the dimensions or in working out the figures.

Periodical inspections are so much waste of time unless a working inspector is on the ground during the whole time of construction. It may ease an engineer's conscience to think that he has examined the work and chalked this and that to be seen to, but in the majority of instances the paint brush is all the consideration such instructions are treated with. Contractors may make every endeavor to give good work and materials, but the opportunities for scamping are so numerous that it requires the greatest vigilance on the part of the working inspector and all concerned to reduce bad work to a minimum. Nearly every portion of the work is done by the "piece," which is a source of evil. The various gangs of smiths, platers, rivetters, and others work at high pressure, and will take advantage of everybody and everything in order to push things through. Watch for a moment a gang of platers; they throw on the plates and seldom take them off again if there is any other means of making them passable, no matter how severe the remedy they are obliged to adopt in doing so. Watch the rivetters following them up; if the holes should happen to be half blind they are not rimered so long as a drift is at hand with which to distort and distress the iron. If they can manage to get hold of short rivets they do not scruple to use them, they being more easily put in.

If the rivets are heated only at the point they do not require quite so much hammering as when heated throughout, but then they will not fit the holes, and may even be loose. Do not fancy they will be cut out on this account, the rivetter will soon make them to all appearances tight with his hammer when they are cold. Rivets treated in this manner will not remain tight if the structure is subject to much working. Loose rivets may easily be detected by the inspector tapping them with a small hammer. These little items which go far to make good work can alone be seen to by a competent working inspector being always on the ground.

Contractors to a great extent estimate the quality of work which will suffice and the character of the engineer by the style in which the specifications and drawings are got up. If the specified test and requirements are fair and just, and the drawings made in a workmanlike manner, they will be careful in their movements and have a certain amount of respect for the engineer's opinion. If, on the other hand, the drawings are unworkmanlike, and, as will generally follow, the specification is arbitrary and unreasonable, they put on a

*Paper read before the Liverpool Engineering Society, June 20th, 1877.

percentage to their prices to cover contingencies, and in the event of getting the work congratulate themselves on knowing that there is more than one way of killing a goose.

The nature of the specification depends on very many circumstances, but in all cases it should be as clear and concise as possible, and should be drawn up with the view of explaining those things which the drawings cannot be made to fully show. The main object of the specification is to give the requirements which the material and work will have to comply with, and general instructions as to the manner of undertaking and executing the contract. Its pages should not be crammed with dimensions and badly-worded descriptions, which can and ought to be better shown by the drawings. If the drawings are properly prepared, a clause such as "The work is to be carried out in strict accordance with the drawings Nos. 1 to —," will save the time of both engineer and contractor. Nothing is more worrying than to have to send to the office for the specification in order to ascertain some dimension or matter which ought to be figured or described on the drawings.

Drawings of ironworks should be as complete as it is possible to make them, free from all ambiguity, and leaving no room for doubt as to what is intended. In order to effect this dotted lines must be largely employed, it being impossible to confuse a drawing by putting dotted lines in their proper places. It must be borne in mind that the drawings are not to be submitted to a Parlimentary committee, but to men accustomed to most complicated mechanical drawings. A working drawing is not necessarily pretty; it should be neatly and accurately made, and require no explanation whatever.

The pitch and diameter of the rivets should in all cases be marked upon the drawings, and their relative position in the structure should be pointed out. In the construction of a bridge, it is generally necessary to draw the whole or parts of it full size with its required curve or camber. This is principally done in order to arrive at the correct length of its separate portions, and the exact relative positions of the rivets which by this means are accurately ascertained. These positions are then marked on a template, from which any number of similar plates or bars can be made.

It is not unusual to specify that when one portion of a structure is to be rivetted to another the holes must be made with such accuracy that a template with studs fixed in the positions of the rivets, one-sixteenth less than them in diameter, shall enter all the holes at the same time, and go completely through the various thicknesses of the plates. If the holes are not fair to one another the shearing area of the rivet is reduced, and therefore the joint will not be of the calculated strength. To cover this fault it is advisable in calculating the number of rivets to consider their diameter one-sixteenth less than that shown on the drawings. All rivets should have a good and sufficient head and snap, and when inspecting the construction of ironwork this should be enforced.

To make a countersunk point requires an additional length of rivet over and above that necessitated by the thickness of the plates through which it passes, equivalent to one diameter, and for a snap point about one and a quarter diameters of the rivet.

Time will not permit of the considerations affecting the adoption of the various types of girders being gone into. It may still be well to give a warning protest against accepting too implicitly the supposed economy of using rolled sections as beams. When it is requisite to have them of considerable depth and of such lengths as to necessitate jointing, their use is as a rule attended by anything but economy.

It is no uncommon thing to find one engineer, by judiciously designing his girders, making the same amount of iron do twice the work that another engineer can do under similar circumstances, and at the same time at a less cost per ton.

It is a very important maxim to bear in mind that the same amount of material put into one girder will generally do more work than if distributed over two or three. Firstly, because there are certain practical limits to the thickness of webs and position of stiffeners. Secondly, because the more numerous the plates in the flanges the nearer their actual weight will approach that required by theory, and the greater the percentage of effective section to gross section.

All designs should be as free as possible from angles and tees, with complicated bends and joggles, and bent and cut plates should be few and far between.

The stiffeners to the web of a plate girder, if splayed out clear of the angle irons, will cost about 50 per cent. less for smithing than when made to fit close round them, and answer their purpose equally well. This class of stiffener cannot be adopted when the flanges are too narrow to admit of four rows of rivets, but when the flanges are of sufficient width to admit four rivets at one cross section, but require only two for their construction, the additional rivets can generally be put in without taking from the strength of the girder. The flanges of plate girders usually possess an excess of strength at points not very far distant from each other, owing to the unvarying thickness of the plates; it is at these points that the stiffeners should be put in, if they can be so arranged as to be equidistant. If this cannot be effected, the cost of making extra templates, and the trouble caused during the construction, will more than counterbalance any economy to be derived by taking advantage of this fact.

The position of the rivets, their diameter and pitch should be carefully considered, as it is on them that the whole strength of the structure depends. No amount of extra metal in the body of a tie can compensate for a badly constructed joint. Carelessness or ignorance of these small things at once indicates the amateur designer, who is often led astray by the facility with which he can ornament his drawings with these little circles or red crosses.

Many engineers specify for every class of work that all rivet holes are to be drilled, so increasing the cost of the work by not less than £1 per ton.

This is a mistake for experiment proves that with good ordinary iron the damaging effect of the punch is small. Even with mild steel plates Monsieur Barba, constructor to the French Navy, has found by experiment that the damage extends only to a distance represented by a zone 1-25 in. in thickness round the hole.

The question whether to employ punched or drilled holes ought to be a matter to be decided by the engineer in each particular instance. If a number of plates are to be rivetted together, or an intricate junction made, the drilled holes will be more accurate unless great care is exercised by first class men at the punching machine. When a simple plate and angle iron are to be put together the balance of strength in favor of drilling is not sufficient to sanction the extra cost.

With punched work some idea of the quality of each angle, plate, and bar may be formed by examining their respective punchings as already pointed out. A want of proper welding on the laminæ of the iron may also sometimes be detected when punching. It is difficult to punch near the edge of very bad iron, but a drill may be put through almost any rubbish.

In the early days of engineering it was a common practice to make things strong enough on the supposition that a structure tested with something more than its working load would be quite safe, which has already been shown to be erroneous. Still on the completion of the structure and before it is painted, it should be tested with a proof load and the deflection taken. This is simply a test of workmanship which ought only to be carried out in conjunction with the test of materials. Hard brittle iron under this test may appear superior to a better and more desirable quality, and a part of the structure may be on the point of breaking and yet not yield sufficiently to materially alter the deflection.

Carrying out tests will involve an additional expense, but it is small, and against it the engineer may set the gain of esteem on the part of every honest contractor, and the satisfaction of knowing that he is obtaining good materials and workmanship. When it is considered that "iron is not always iron, for sometimes it is simply rubbish," tests are absolutely necessary to enable an engineer to state with confidence what is the maximum safe working load of a structure. When dealing with constructions subject to much vibration or great changes of stress, iron like Portland cement becomes a dangerous material in the hands of those ignorant of its qualities.

If an iron structure is well designed, erected, and taken care of, there can be no reason why the term "life of ironwork" should not become obsolete. Iron imbedded in concrete has been found at the expiration of years as free from decay as on the day of its manufacture. It is said, in fact, that water has no action on iron at the ordinary atmospheric temperatures, providing air be excluded. The usual means resorted to to effect this is by giving the ironwork a succession of coats of paint, and the limits of decay by corrosion are entirely governed by the efficient state in which this paint is maintained.

Keeping these facts in view, the ironwork should be designed to allow of free access to all parts for periodical examination. Painting the internal surfaces of box girders and cellular flanges has always been a difficult and costly operation. It is therefore fortunate that experience and science have demonstrated that such forms of construction are seldom necessary in modern practice. They may almost be considered as types of a bygone age, to slavishly imitate which, in many cases, shows ignorance of the principles and practice of modern girder work.

The paints used for ironwork are of every description, name, and quality. The usual varieties employed for preserving it against corrosion may be divided into lead, iron, oxide, silicate, and tar paints. Differences of opinion exist as to the relative merits of the first three descriptions, but the experience of several foremen painters connected with establishments in this town, is decidedly in favor of lead paints when of good quality, and mixed with good oil without spirits. Unfortunately there are no reliable practical tests to ensure good materials alone being used; consequently both the colors and the oils are often inferior in quality, and much adulterated. For these reasons, and on account of cheapness, iron oxide paints are by some preferred.

A little white lead mixed with the red makes it go farther, and easier to work into corners. If the first coats are put on with pure red lead, owing to its weight it is liable to run off; but the last coat should consist of red lead alone.

The tar paints are more often used for ironwork which is not to be seen, such as water pipes, floor plates, bridges, and girders which are to be built into masonry or brickwork. It is cheap, and answers well for such purposes, and for sea work, as it is said not to foul so readily as lead or other paints of a finer description.

A good rough paint of this class may be made by heating ordinary coal tar, and mixing with it finely sifted slaked lime, in the proportion of between half a pound and a pound of lime to a gallon of tar, adding sufficient naphtha to render it of a convenient consistency for laying on. This composition should be applied while hot, but care should be taken not to make it too hot, nor to keep it over the fire too long, or it will lose its essential oils, and be reduced to a substance in all points resembling pitch. Some positions admit of the paint being sanded, in which case it should be done, as it adds to its durability.

Before painting ironwork it is usual to give it a coat of boiled linseed oil, applied hot, this forms a kind of varnish and is an excellent preparation for the after coats of paint. Opinions differ as to when the coat of oil should be applied. Some engineers specify that the iron shall be brushed over or dipped in oil while hot from the rolls. The efficacy of this method is doubtful, as the iron in undergoing its workshop manipulations is subject to rough treatment, and portions of its surface are sure to become exposed. Others specify that the iron shall be brushed over with hot oil just previous to the various portions being plated together. This answers well for ordinary work, as by the time it has gone through the workshops the blue shales have to some extent been knocked off.

These blue shales are in a greater or less degree inseparable from the manufacture of the iron; but it is very important that they should be removed by some means or other before the paint is put on, for if not, in a short time they will peel off and bring the paint along with them. The best way to guard against this is to have the iron work put together in the yard and tested previous to either oil or paint being put upon it. A slight rust will form over the whole surface of the work, which will cause the blue shales to fall off. The rust should then be scraped off and the whole of the work rubbed down, which will render the surface parti-

cularly fitted for receiving the after coats of oil and paint. The oil should follow up, as closely as possible, the man cleaning the work. It is almost needless to point out that the efficiency of this method entirely depends upon the thoroughness with which it is done, and no engineer is justified in specifying it unless he purposes putting an inspector to see that it is properly performed.

It may be well to point out that for foreign up-country work too much care cannot be exercised to insure that it is properly painted in the first instance.

In conclusion, the author will only briefly refer to Professor Barff's recently discovered method of coating iron with magnetic or black oxide. This he effects by subjecting it to steam at a high temperature of about 1,200° Fahr. for six or seven hours. It is said that iron so treated will resist a rasp and bear any amount of exposure to weather without showing any signs of corrosion.

Experiments on a large scale are now being carried out by the Professor and Messrs. Penn with a view of testing its practical application to constructive purposes. If it be demonstrated by them and by subsequent experience that the process is capable of practical application to iron employed for structural purposes, there are halcyon days in store for wrought iron girder work.

DISCUSSION.

MR. HUDLESTON wished to know on what authority the author spoke so favorably of American bridges; for, from the descriptions that reach us of their failure, he would infer that a greater strain was put upon them than was usually allowed in this country.

MR. VERNON PETHERICK thought one point of great importance in the design of wrought iron girders had not been mentioned in Mr. Graham Smith's paper, that was so arranging the rivetting that the whole or greater part could be done by machine rivetting, thus ensuring not only better work but a great saving in cost.

MR. CLANCHY said that as regarded the comparative advantages of pin and rivetted joints, he was decidedly in favor of the former in new countries and remote situations where the procuring and transport of cumbersome machinery was a matter of serious consideration and expense. The impossibility of obtaining skilled rivetters operated against the application of rivetted joints up country. He had some experience on the San Paulo and Rio de Janeiro Railway in the Brazils of the superiority of pins over rivets as regards the facility and speed of erection in bridges with spaces varying from 60 ft. to 160 ft. The general type of these bridges was that known in the United States as the Linville Truss, of trapezoidal form, the compressive members being circular in section, and composed of four segmental pieces turned flat at the edges and rivetted together. The tension members were flat and round bars, the former used for the bottom member of the bridge, and diagonal ties being in form similar to the links of a suspension bridge. The round bars were used for the horizontal diagonal bracing to secure the cross girders. All the fastenings used in putting the bridge together were of steel. Among the most striking advantages of the system were the light and graceful appearances of the bridges, and the facility and speed with which the several pieces were put together. These being in convenient lengths, and not exceeding 7 or 8 cwt. each in weight, were put into position without the aid of machinery. Most of these bridges were used in connection with screw piles in localities where building materials were not to be had. The railway had to be carried over level swampy ground, a subsoil of peat and plastic white clay, with a bottom of hard gravel 15 ft. or 20 ft. from the surface. The time occupied in erecting a 20-metre (65 ft.) span bridge, with a gang of about fifty men, and including the screwing in of the piles, was generally about six days, and that without the aid of steam or any hoisting machinery.

MR. WILKINSON SQUIRE quite agreed with what the author had said in regard to having an inspector to look after the construction of ironwork. He had had some experience in ironwork, and was fully of opinion that the imperfections in workmanship could alone be detected and remedied by a working inspector being always on the ground.

MR. MAGINNIS was of opinion that the question of piece work mentioned in the paper was deserving of special attention in all rivetted ironwork. He thought it should, if possible, be entirely abolished, as although adopted by contractors on purely economical grounds, it in most cases turned out to be eventually the most expensive. He instanced a case of an iron vessel of about 500 tons register. This vessel made one coasting voyage, and the iron deck was found to be sagging down with the deck load of coal which she was carrying, and she was also found to be making water to a serious extent. On entering the hold to make an examination he saw daylight through one of the rivet holes in the side of the vessel under the stringer plate; the rivet was there, but daylight was there also. Few of the other rivets were found to be properly up at the head, and in several cases the heads were upward of a quarter of an inch from the plate. This vessel was plated, rivetted, and entirely built by piece work, and after the report of the survey it cost upwards of £3,000 to put her in a seaworthy state. Another instance of the serious and false economy of the system has recently been found in two of the largest steamers trading to this port, they having after a few voyages to put into dry dock and have extensive repairs done to them at a cost of some thousands of pounds. One firm of shipbuilders who rank very high for the strength of their vessels, knowing the defective work done by piece work, entirely ignore it in rivetting the shells of ships. These facts he thought sufficient to fully prove how much piece work should be condemned, as even under the most minute inspection the dangers of the system are scarcely to be avoided.

MR. HENRY TURNER said that during his experience of rivetted work for boilers, ships, and girders, he had found very little difference in the quality of rivetting done by piece work as compared with that paid by the day. He thought a workman, inclined to be careless, would be so, however he might be paid. In piece work the workman cuts out and makes good all bad rivetting at his own expense, in day work he does this at the master's cost. This, in his opinion, quite counterbalanced the extra care and longer time that might be spent upon day work. In his opinion the great secret of producing good work is supervision, and he would say that all rivets had been tested by foremen appointed for that purpose in the large engineering and shipbuilding establishments with which he had been connected.

Manufacturers pay their men for sound work, and are anxious to supply their customers with the same for their own sake, as they have a great deal to lose and nothing to gain by sending out bad work.

Referring to the remarks made by the last speaker about the bad quality of rivetting in the hull of a steamer which was found to be in a very leaky condition after a single coasting voyage, and requiring repairs to so large an extent before she could be placed on her station. He could endorse this statement, for he happened to have been with the firm who executed the repairs, but he considered this state of things to be more due to faulty design than workmanship. The weakness was in the ship herself, as she had been built with the frames and deck-beams continuous and with a large radius, say between 5 and 6 feet at their junction; and without the strengthening corners and gussets. This defect caused the vessel to work so badly that she opened nearly all her butts and seams, and caused the rivets to be leaky. Part of the deck was taken up and the deck beams properly connected to the frames in the usual manner, hence the great expense for repairs and alterations.

MR. ALEXANDER ROSS complimented the author on the very practical and instructive paper he had just read. Alluding to his remarks on the effects of temperature on ironwork and the cambering of bridges under a hot sun, he believed that at the testing of one of the tubular bridges on the Chester and Holyhead Railway a similar effect had been observed. The loading of the bridge had been commenced early in the morning and occupied the first part of the day. The depression of the girder was eagerly watched for, but, to the surprise of all, instead of being depressed the girder was actually rising in the centre as the load increased. This was very puzzling, but the explanation was arrived at that the temperature was low when the loading commenced, and there being at noon a bright sun it increased considerably. The top flange being exposed to the sun's rays expanded more than the underside, which was shaded by itself, thus having the effect of cambering the bridge. Mr. Ross liked the form of testing bar, and thought the method explained by the author of arriving at the percentage of elongation very convenient. The author's remark that the parallel portion of the iron to be tested should run in with large radii to the portions through which the holes are made also applies to the whole of the material composing an entire structure, as any sudden alteration in the form of materials is an undoubted source of weakness. He thought, from his experience on railway work, that iron oxide paint formed a reliable and cheap substitute for red lead.

MR. BIRCH said with reference to the author's remarks on cross piled plates, that his experience had been that beyond certain limits, cross piling was ineffectual to procure tensile strength crossways equal to that in the direction in which the iron was rolled. In fact in plates of odinary sizes the strength, as a rule, would always be three or four tons more lengthwise of the plate. In support of his assertion, MR. BIRCH read the following notes on the subject which he had had from one of the largest plate manufacturers in this country whose works, situate in the Cleveland district, are employed in nothing else but the manufacture of ship, bridge, girder, and boiler plates:—

"We do not ourselves think there is so much in cross piling as is generally believed. We find that in rectangular plates of ordinary sizes the strength in the direction of the rolling is to that in the opposite direction as twenty-two is to eighteen. In long narrow strips you may increase the first, but always at the expense of the second. In smaller square plates especially rolled you may make it almost equal in both directions. We do not think that a plate 12ft. by 4ft. 6in. by ¾in. can under any circumstances be made to stand an equal strain both ways, for it would of necessity have to be rolled out more in one direction than in the other; and cross piling does not by any means compensate for the effect of finally rolling in an opposite direction. The percentage of elongation follows very much the final tensile strength—that is to say, it increases or diminishes with the tensile strain endured. Some makers—notably Low Moor and Farnley—are putting down rolls of great diameter and length—say 12ft. long by 2ft. 8in diameter; they make a specialty of large circular plates to flange all around, and with two flanged holes in them for marine boilers. Their object is to obtain equality of tensure for flanging purposes, by an equal amount of rolling in both directions and no doubt they obtain it in this way. The cost, however must be greatly enhanced, for apart from the question of the high class material they use, such machinery is of a most expensive kind in original cost and in keeping in motion. As plates of this description are a very small proportion of the total used for all purposes, it is clear that the size and class of machinery ought to be determined by the bulk of orders, and not by the requirements of exceptional plates. The term cross-piling seems to have come originally from Staffordshire, and is not used at all by manufacturers of plates. We constantly hear of it, however from merchants and consumers who imagine there is something in it, but don't know what. As far as we can gather 'cross-piling' in Staffordshire means making the pile from which the plate is to be rolled with one slab top and bottom lengthways of the pile, and the intermediate space filled up with puddled bars placed crosswise. Our experience is that plates so made are very inferior to plates made as we are in the habit of doing them, viz., with one or more slabs lengthways of the pile top and bottom and the intervening space filled up with plate scrap. This is for ordinary quality. For higher qualities we have several methods of improving the iron though not without increased cost. It is quite probable that plates cross-piled as we have described them may be better than plates made of new puddled bars all arranged the long way of the pile, but we never make them the one way or the other. As before explained, more depends on the direction of the rolling afterwards than on any particular arrangement of piling. You may make up your mind that it is not wise for merchants or consumers to specify anything about piling, or any detail of the manufacture of iron. Their best policy is to specify that the iron shall be capable of bearing such and such tests. They then throw the responsibility on the manufacturer, whereas, in the other way, they take it themselves, for they cannot blame him if he follows their instructions, even though a failure be the result."

In reference to the author's and another's animadversions on rivetting by piece work, while quite agreeing with them that good rivetting is the life and soul of an iron vessel, he thought that it would be a difficult matter for contractors not to work on this system. In a shipbuilding yard renowned for the excellence of its work where he had been, the supervision of the foremen in seeing that the butts and seams were thoroughly and properly caulked always detected any

bad materials or workmanship in the rivets by causing the heads to fly.

Mr. GRAHAM SMITH, in reply, said he thought the few failures of bridges which take place in America should by no means be taken as ground on which to condemn the whole system of bridge building in that country. It usually happens that when the break downs come to be inquired into, it is found such structures depart very considerably from recognized American practice. As to factors of safety being less in America than in England, he was under the impression that they were greater, 10,000 per square inch in tension and 8,000 (varying slightly with design) per square inch in compression being, so far as he was aware, the usual strains calculated to be put upon wrought iron in the United States. With reference to Mr. Petherick's remarks, his only reason for not touching on machine rivetting, and speaking more fully on the question of punched and drilled work was that time would not permit of his doing so. He nevertheless fully appreciated the value of machine rivetting as not only giving more economical but very much better work than hand rivetting, and he looked forward to the day when such machines as Tweddell's portable hydraulic rivetter should supersede, to a great extent, manual labor. As regards the economy to be effected by the use of machines, a short time since he saw 130 rivets, ¾ in. diameter, put in an angle iron beam, in ordinary work, in half an hour by one machine; the labor employed to do this was that of two men conducting the rivetting, one nipper working the machine, one carrying rivets and drifting, and one heating rivets. The whole of their wages would amount to about the same as the wages paid to a gang of rivetters who would be restricted by their club rules to 180 rivets of the same diameter for a day's work.

The following experiments carried out by Mr. Cochrane (*vide* Minutes of the Institution, vol. xxx.) tend to show that the punch does not damage iron to the extent supposed by some engineers. A bar of Low Moor, 2 in. by ½ in., with a drilled hole ⅞in. diameter put through it, sustained 235 cwt., and with a punched hole 226 cwt. With bars of hard crystalline iron of the same dimensions, that with the drilled hole sustained 250 cwt., and the punched hole 244 cwt. With bars each with three holes, one drilled, one punched, and one punched ¾ in. and drilled to ⅞in. diameter, in all cases they broke through the punched hole. This would be inferred from the foregoing experiments, still the results are well within the limits of variation in the breaking weights of our best irons. He was glad to find that Mr. Clanchy was in a position to corroborate his (the author's) good opinions of American bridges, and that Mr. Ross had come forward with so convincing a proof of the effect of changes of temperature on iron structures in this country. Mr. Ross's remark "that any sudden alteration in the form of materials is an undoubted source of weakness," is well substantiated by actual practice. It will generally be found that fractured axles, forgings, castings, or rails, fail at sharp angles or sudden alterations in section; liberal fillets should, therefore, be employed in cast, rolled, and other forms of iron. On the question of cross piling and rolling, he was inclined to adhere to the text of his paper, as differences of opinion exist on this point even among ironmasters. It might be well to point out that the plates which were mentioned in the paper on account of their length could only have been rolled lengthways of the plate. They nevertheless unquestionably had a greater tensile strength across the plate than with the length of the plate, and the fibre was undoubtedly across the plate. Many of the plates were tested to ascertain this point, both by breaking off the corners when cold and by bending portions of them to destruction while hot. The means employed to manufacture these plates whatever they may have been, did not enhance the cost of the iron to any great extent, the ironwork of which they formed a part being executed at a very reasonable price. There is so very much to be said both for and against piece work that, considering the lateness of the hour, he would simply remark that in his opinion with proper supervision piece work might with advantage continue to be adopted on ordinary girder work.

At the close of Mr. Graham Smith's remarks, Mr. M. E. Yeatman, vice-president, proposed a vote of thanks to the author, and the meeting adjourned.

There are 811 railroads in the United States, of which it is said only 196 pay dividends.

THE RIVER THAMES.*

BY JOHN BALDRY REDMAN, M. INST. C. E.

(*Concluded from page 269.*)

Sheerness is situate on a tidal estuary, the mouth of the river in effect, 5 miles in width. At Gravesend the width is only ½ mile; but in the Port of London, although the distance from Sheerness is nearly three times as great, the width of the channel diminishes gradually upwards, and the river through London is nearly one-half the width it is at Gravesend. This, however, is somewhat qualified by the fact that the river diminishes rapidly in width above Gravesend; as between the upper part of Northfleet and Tilbury Ness, 2 miles above Gravesend, it has lost one-third its width and is there only wider than in the Port of London by one-half of the mean width of the channel. It widens, however, again in the two upper reaches to the same width as at Gravesend over a course of 4 miles, and hence upwards diminishes with tolerable uniformity. The absolute level of the surface of the tidal column at high water must vary from a regularly ascending gradient due to these causes.

LEVEL OF HIGH WATER ABOVE BRIDGE.

This is illustrated by a series of tidal observations, by Mr. Simpson, of the high water levels in Chelsea Reach in 1841–43, and by those taken for the metropolitan Sewers Commissioners in 1849. The result of these observations proves that at that period a depression at high water commenced just above Westminster, for Mr. Simpson's readings made high water 4½ inches to 6 inches lower at Chelsea, and those of the Sewers Commissioners 12 inches lower at Battersea Bridge than at London Bridge, and the low water level 15 inches higher.

PRESENT HIGH-WATER LEVELS.

That this high water depression does not now exist is certain, as the great tide of the 20th of March, 1874 made practically a pond level, being 4 feet 4 inches above Trinity Standard at Teddington Weir, as it was at Westminster, and the tide of the 18th of April, 1874, which only rose to within 8 inches of Trinity standard at the Gravesend Terrace Pier, *i. e.*, so much below it rose to 14 inches above it at Blackwall, 2 feet at London Bridge, 2 feet 3 inches at Westminster and Lambeth, and 2 feet 4 inches at Richmond, in effect regularly ascending at high water.

If causes existed prior to the erection of the modern Thames Embankments, in the sudden widenings of the river above bridge, to produce a lowering of the surface of the tidal column, the above facts show that it has been removed by these works. If, in raising the tidal surface these works have produced some temporary trouble, they have at the same time proved self compensating, and requiring no tidal accumulating reservoirs to store up water formerly overflowing the mud foreshores. A consideration of the above will show, that the estimate of compensation due to the embankments raising the surface of the tidal column might be largely increased, as the estimate of 6 inches was only taken above a plane, nothing being added for the fall of high water above Westminster, which tidal observations would appear to establish.

MODERN DEVELOPMENT OF TIDE.

At Sheerness the high water has been (as adduced from the average of the whole years' tides) 4 feet 8 inches to 5 feet 2 inches below Trinity standard, and low water 18 feet 4 inches to 18 feet 9 inches below Trinity standard, giving a mean range for the entire year of 13 feet 7 inches. At the London Docks the high water has been 1 foot 5 inches to 1 foot below Trinity standard, and low water 18 feet 5 inches to 19 feet 3 inches below Trinity standard, giving a mean range for the entire year of from 17 to 18 feet, showing that the tide ebbs much lower in the Port of London than in former years.

METROPOLITAN LOW-WATER CHANNEL.

A comparison of the last issue of the Admiralty chart with those of earlier date shows that, due to the increase of tidal volume and dredging of shoals, the low-water deep channel has been extended upwards past Woolwich and Blackwall. There are, however, two artificial barriers to this continued extension upwards, or at least to its availability for navigation. The first is the Thames Tunnel,* which has only 8 feet depth of water over its crown at low water of spring tides, with a normal low-water depth above and below of 10 to 11 feet; and the same at Waterloo Bridge, where, from artificially keeping up the river bed, by throwing loose stone around the piers to prevent their being undermined, there is only under the sole low-water navigable arch, on the Middlesex side, 8 feet at low-water, with a normal depth above and below of 10 to 11 feet.

DEPOSITS.

One important question has not yet been referred to, viz., in what way the altered conditions of the river have affected the deposition of silt which comes up with every tide, and which at an early period was checked by, and thus deposited below, Old London Bridge. Subsequently the wide reach at Hungerford, 1,200 feet across, afforded a resting place for the deposit, which became obnoxious by the continued lowering of low water.

Undoubtedly certain accumulations have increased of late years. In the Pool more mud is said to gather on the foreshores; on the Surrey side above and below Waterloo Bridge the mud increases; also in front of St. Thomas's Hospital; and the wharfingers of Millbank complain of deposit, which may also be observed on the Middlesex shore along the face of the embankment, between Westminster and Waterloo Bridges. Many of these alluvia are local, caused by rapid recessions and projections, and no doubt admit of mitigation. But the general question of disposing of the mud must necessarily become a larger one the more the embankments are extended.

RELATIVE HIGH-WATER LEVELS, SHEERNESS AND LONDON.

With the information yearly published by the Government, the real hydraulic condition of the river should be better understood. A cursory examination of the Admiralty tide-tables, and the journals kept at the London Docks, and at H. M. Dockyard, Sheerness, will show that Mr. Lloyd underestimated the difference at high water from Sheerness to London by nearly one half, and yet his results are unquestioned, and conclusions are frequently based on them.

The late Mr. Beardmore, M. Inst. C. E. in January 1856, stated at the Institution, "The mean high water taken at London Bridge for one month in 1849 by the Metropolitan Sewers Commissioners was 1.02 foot above that of Sheerness taken in 1827–8–9." In effect this comparison yields not much more than one-fourth of the actual difference. He stated at the same time that the low-water difference was 6 inches, and was lowest in London. He adds however, that the mean ranges were, London, 17.578 feet: Sheerness, 14.472 feet. The difference of range would, therefore, be 3.106 feet. The low-water difference Mr. Beardmore gave as 0.598 foot, so that by only one month's observations, taken for the Metropolitan Sewers Commissioners, the high-water difference was really 2.508 feet. But the Sheerness range was overestimated, and the high-water difference, therefore too low. The real high-water difference for the whole years' tides for leven years, 1833–1843, was 3 feet 6¾ inches; and for the three years 1873–74–75, 3 feet 10 inches. It will thus be seen that there has been a gain of 3 inches of late years, due to the modern development of tidal momentum above bridge.

The Author had an opportunity of observing the highest tide of the past year at Harwich, on the afternoon of the 19th of September last, which flowed 8 feet 9 inches above Ordnance datum, or 3 feet 9 inches below Trinity standard. At Sheerness the same tide was by Admiralty Dockyard measurement, 3 feet 6 inches below Trinity standard; and at the London Docks, by Captain Maitland it was 1 foot 7 inches above Trinity standard, and only 1 inch higher than the Admiralty calculated height. So that high water of that day in London was relatively 5 feet 4 inches, and 5 feet 1 inch higher than at Harwich and Sheerness. In effect, a mean spring tide high water difference. Mr. James Walker, Past-President Inst. C. E., in a report of the 13th of December, 1841, on the Thames Embankment

*A Paper read before the Institution of Civil Engineers, London.

*From Mr. Harter's remarks there would appear to be a minimum thickness of ground above the tunnel of 16 feet below the river bed.

question, accepted Mr. Lloyd's results saying: "At present the level at high water at London Bridge is 2 feet higher than at Sheerness, a length of 40 miles; and at London Bridge it is on the average of a series of observations, when the river was free from land floods, 1 foot lower than at Richmond Bridge," etc.

It is due to to the late Mr. Thomas Page, M. Inst. C. E., to state that in his letter of the 1st of July, 1843, addressed to the then Chief Commissioner of Public Works, he directed attention to the fallacy of results based on Mr. Lloyd's, and gave the true state of the case in the following words: "The level of high water at London Bridge above the high water at Sheerness was, for the month of February this year, more than 3 feet 10 inches, and for the months of March and April sometimes 4 feet and even 5 feet higher than at Sheerness," etc.

The morning and afternoon tides at high water of the 2nd and 3rd of January last marked on the London Docks Shadwell tide gauge, as follows:—

Feet.	Inches.	Feet.	Inches.	Feet.	Inches.		Feet.	Inches.
20	4	29	1	23	8	and	28	5;
or 4	0	3	0	3	4	"	3	1

above Trinity standard.

And on the Sheerness tide gauge:—

Feet.	Inches.	Feet.	Inches.	Feet.	Inches.		Feet.	Inches.
10	9	10	5	9	5	and	9	8;
or 0	6	0	10	1	10	"	1	7

below Trinity standard.

The London high water in each case being relatively highest in London by—

Feet.	Inches.	Feet.	Inches.	Feet.	Inches.		Feet.	Inches.
4	6	4	7	5	2	and	4	8

The morning tide of the 2nd of January was also 3 feet 4 in hes above the calculated height by the Admiralty tide-tables, and this tide was 4 feet 3 inches above Trinity standard at Westminster. The continuous elevation of high water during these springs is due largely to the vast quantity of land flood water.

RELATIVE LOW-WATER LEVEL, SHEERNESS AND LONDON.

Illustrative of this question, reference may be had to the Admiralty Chart No. 2484, 1830–33, corrected to 1857–59, and to 1871, which has the following note:—

"Datum.—Low-water average springs = 3 feet 3 inches on the tide gauge at the Wapping entrance to London Docks, or 19 feet 8 inches below Trinity H. W. mark. The low-water level was transferred down the river from the above Datum, which is 1 foot 7 inches lower than the corresponding low water at Sheerness."

This closely approximates to the Admiralty Chart No. 1607, 1844, corrected to 1858–61, and to 1871.

Note.—"Datum of soundings being 8 feet on the index at the caisson at Sheerness, or 13 feet 2 inches below Lloyd's brass plate on the south pier at the Boat-house Chamber."

The effect of these notes is that—

Low water in London was 19 feet 8 inches below Trinity standard, and at Sheerness 11 ft. 3 in. + 8 ft. = 19 ft. 3 in. below Trinity standard, or a London low water of 5 in., instead of 1 foot 7 inches; but low water is now 2 feet 9 inches on the sill of Wapping entrance of London Docks, in lieu of 3 ft. 3 in., or 6 in. lower, therefore London low water is now lower than at Sheerness by 11 in.

This is shown by the Admiralty Monthly Tide Tables; the first Chart note remains, as, if altered, it would affect the sounding throughout to the extent of 6 inches.

	Feet.	Inches
Admiralty half-spring range in London =	10	4
Mean-tide level below Trinity standard	10	0
Low-water springs below Trinity standard	20	4
Admiralty half-spring ranges at Sheerness	8	0
Mean-tide level below Trinity standard	11	3
Low-water springs at Sheerness below Trinity standard.	19	4
London low-water springs lower than at Sheerness by	1	1

There is, therefore, a difference of only 2 inches in the two Admiralty computations, *i. e.*, the Charts make the London low water relatively lower than at Sheerness, 2 inches less than the yearly tide-tables.

Practically taking the whole years' tides for 1873, 1874 and 1875, the mean low-water difference of the entire year is only 5 inches, and lowest in London; although a large number of tides may be selected showing a much greater difference.

A low ebb of the 21st of September last (A. M.) was 20 feet 1 inch below Trinity standard at Sheerness, and 20 feet 6 inches at the London docks; or 5 inches lowest at the last, indorsing the results in the last Admiralty Chart.

On the 2nd and 3rd of January last, however, the morning low waters at the Hadwell entrance of the London Docks were 7 feet 6 inches and 7 feet on the gauge, or 17 feet 10 inches and 18 feet 4 inches below Trinity standard. And on the Sheerness tide gauge 7 ft. 3 inches and 8 feet 3 inches, *i. e.* 18 feet 6 inches and 19 feet 5 inches below Trinity standard. The Sheerness low waters were therefore relatively lower than in London by 8 inches and 1 foot 1 inch: this comparative elevation of low water being also due to the enormous quantity of land water coming down.

GENERAL QUESTION.

The subject of the present Paper must be of great public interest, and when the sanitary character of the river, making London as it does one of the most healthy and beautiful cities in the world, and its being the vehicle of the greatest commerce the world perhaps ever saw, are considered, the conclusion is pointed to that it is one of vast national importance. No doubt the whole question demands, and will receive, continued and greater attention and consideration; the above facts and the inferences drawn therefrom are offered as an instalment towards its illustration. The combined causes of the altered modern condition of the river, viz., the removal of old London Bridge, that of Blackfriars and Westminster, the systematic dredging of shoals bringing the tidal deep low-water channel higher and higher up the river, and the modern embankments, have brought high-water level in the Pool to the same height at Teddington, and correspondingly lowered the low-water level and scoured the bed. These accumulated causes, producing results of comparatively slow and gradual operation, becoming more and more intensified each year, during nearly half a century have added about 33 per cent. to the above-bridge tidal volume operating twice every twenty-four hours, thus showing how altered the metropolitan condition of the river now is, and how great are the beneficial results in a commercial and sanitary view, attended, however, by the comparatively lesser evils arising from the non-embankment of the low-lying portions of the metropolis, and which, as these tidal improvements are developed, will be intensified year by year until met by some well-considered and comprehensive measure.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Louisville Bridge & Iron Co., of Louisville, Ky., are running on full time and employing about 400 men; 225 of whom are engaged in the shops of the Company, and 175 in erecting structures in different parts of the country. They have the contract for the Cincinnati Southern Railway bridge, over the Tennessee river, about six miles above Chattanooga, which is to be a wrought iron structure consisting of six spans of 210 feet each, one draw of 280 feet and one span of 260 feet, and is to be completed Jan. 1st, 1878. They also have contracts for bridges on the Louisville, Nashville & Great Southern Ry., Mississippi & Tennessee R. R., and Natchez, Jackson & Columbus R. R., and also several contracts for highway work. They have just completed, for the Indianapolis Belt R. R., a double track wrought iron triangular truss bridge, which is the only double track iron bridge in the state of Indiana.

RAILROADS.

The Chicago Rock Island & Pacific R. R. has declared a quarterly dividend of 2 per cent. payable Nov. 1.

A contract has just been let at Amsterdam for the delivery of 20,000 iron sleepers to the Netherlands state railways.

The officers of the Grand Trunk R. R. have decided to build machine shops at the Fort Gratiot station, to cost $40,000.

A narrow gauge R. R. connecting Straitsville and Zanesville, Ohio, at an average cost of $12,000 per mile is on the *tapis*.

The Chicago Milwaukee & St Paul R. R. has declared a quarterly dividend of 3½ per cent. on the preferred stock, payable Oct. 16.

During the seven months ending July 31st, England exported 126,684 tons of steel rails, as against 63,737 tons last year, up to the same date.

The gauge of the Columbus, Cincinnati and Indianapolis R. R. is being narrowed to four feet eight and a half inches, to conform to connecting lines.

A dispatch from Yuma, Arizona, says the first regular train from San Francisco crossed the bridge over the Colorado river yesterday. Grading and track-laying is being pushed eastward rapidly.

The directors of the New York Elevated railways have resolved to commence constructing an East Side line to all ferries, Grand Central Depot and Harlem river, and to lay a double track on the West Side.

Lucius Robinson of Newport, Vt., late manager of the Montreal, Portland & Boston R. R., entered an action in Montreal against that company for $50,000. It is also to annul the transfer of certain railway shares.

The Marietta & Cincinnati R. R. has just completed a new and elegant car for the special accommodation of card players. It was attached to Col. Nash's train last week; it is superbly upholstered and amply furnished with light.

Articles of incorporation of the St. Joe, Osceola & Des Moines narrow-gauge road, capital $1,000,000, and the St. Joe & Des Moines narrow-gauge road, capital $225 000, have been filed with the Secretary of state at Des Moines, Iowa.

The Canada roads are said to be about closing the purchase of the Chicago and Lake Huron R. R., now completed from Port Huron to Valparaiso, Ind., and completing their independent connection with Chicago by building a link of fifty miles.

The Adams County People's Defender says that the Cincinnati & Winchester narrow gauge R. R. now proposes to come down Sunfish Valley and connect with the S. J. & P. road at Waverly, Illinois, thus saving fifty miles of road to the coal fields.

The Missouri, Iowa & Nebraska R. R. which now stops at Alexandria, Mo., is seeking to make Keokuk, Iowa, the eastern terminus. The company asks the right of way into the city and a bonus of $10,000. The council has the matter under consideration.

The new steam street car purchased by the Mt. Auburn Street Railroad Co., of Cincinnati, of the Baldwin Locomotive Works, of Philadelphia, was tested on the line of the company in the former city, on the 26th ult., and pronounced a perfect success.

The route for the railroad up Prospect mountain, Lake George, in New York state has been surveyed and found to be more feasible than expected. The distance from a carriage road at the foot clear up to the Mountain House, is 5,600 feet or about one and an eighth of a mile.

Hon. Geo. Irvin and Malhiot, Commissioners of the North Shore Railroad, and Mr. Stark the Engineer are in Ottawa, Canada. Among other matters relating to the road, that of the station at Hull is to be decided, and the road is expected to be in running order to the latter place in about three weeks.

The Indianapolis *Sentinal*, says: "the President of the Chicago and South Atlantic road, believes, that the prospects for an early completion of the line are brightening. Advantageous arrangements have been made for the completion of the Chicago end of the line, while at Port Royal, on the south Atlantic, the prospects are most brilliant."

The tunnel on the extension of the railway to San Rafael, Cal. is completed, and the first locomotive passed through it a few days ago. This aperture in the hill is certainly considerable of a hole. The tunnel is 1,300 feet in length, 18 feet in hight and 14 feet in width in the clear, and is heavily timbered.

The Pittsburgh, Fort Wayne & Chicago R. R. company has restored the 10 per cent. reduction to their employés, and the rumor is that the Pennsylvania company will also accede to the same demands made by the employés at the time of the strike. The Fort Wayne men were paid off at full rates.

"The good city of York, England," says an English

exchange, "may now boast of having the largest railway station in the world, a boast which means something in these days of railway extension and architectural improvement. The length of the platform is 1,500 feet, the covered platform of the station 800 feet, the breadth 234 feet, and height 50 feet."

The Bay & Coast narrow-gauge R. R. is now completed from Newark to San Lorenzo, California, a distance of about thirteen miles. The company expect to have their construction trains in Alameda by December next, but will not run passenger cars until the road is thoroughly graveled—probably next spring.

In the first seven months of this year the Pacific R. R. shipped eastward 61,000,000 pounds of merchandise. The list includes in its leading articles coffee, tea, dried and ripe fruits, vegetables, hides and pelts, quicksilver, salmon, skins and furs, wine, wool, silk and leather. The quantity of wool sent since the commencement of this year exceeds 26,000,000 pounds.

Since the terrible accident at Altoona, Iowa, on the Chicago, Rock Island & Pacific road, the press throughout the State recommended all roads to take more precaution in regard to the means of preventing a similar accident. Mr. J. S. Oliver, superintendent of the Chicago & Northwestern road has taken the initiative in this direction and has issued an order to all employés in regard to their duties in case of storms, etc.

A strike has been inaugurated on the Great Southern and Western R. R. in Ireland, and a cable dispatch from London, Sept. 24th announces, that, in consequence, the postmaster general orders steamers from America to land only the Irish mails at Queenstown and bring the others to Liverpool. The Great Southern & Western R. R. extends from Dublin to Cork, with several branches, and comprises a system of about 475 miles, costing about $35,000,000.

The Grand Trunk R. R. of Canada, has heretofore had no direct connection between Toronto and Buffalo and the nearest way on that road between those points was to go around by Stratford. The road has now leased the Hamilton & Northwestern road between Georgetown, on the main line, and Caledonia, on the Buffalo division, and commenced running trains from Toronto to Buffalo via Hamilton, on Monday last. By this arrangement the Grand Trunk enters into direct competition with the Great Western, and with a road nearly, if not quite as short.

We learn that one by one the towns along the line of the proposed St. Joe, Osceola & Des Moines Narrow-gauge Railroad are voting tax aid. There is little doubt the project will be carried through. The first section of 90 miles from St. Joe to the State Line is well under way. The right of way has been obtained, the road located, and twenty miles put under contract to be completed by January 1st, next. The capital stock is $5,000 per mile, and first mortgage bonds to that amount will be issued. St. Joe contributed $25,000 cash.

Some weeks ago a son of Sir Edward Watkin (well known from his connection with railroad matters) secured a seat in Parliament, through the influence of his father. Young Watkin was Locomotive Superintendent of the Southeastern R. R. company, of which company his father is Chairman. Lately the company in spite of their Chairman, intimated to young Watkin that his services were no longer required, as it was impossible that he could attend properly to their business and to his important Parliamentary duties at the same time. The post from which he is so unceremoniously ousted is worth $10,000 a year. The young man is heart broken, Sir Edward is indignant and threatens to resign, but the company is resolute and no doubt in the right.

Rapid transit is soon to be an accomplished fact in New York City, the recent decision of the Court of Appeals, rendered at Albany being in favor of the elevated railroads. In consequence of this decision the Gilbert Railroad company will resume their interrupted enterprise, and the Elevated R. R. company will immediately construct a road on the east side of the city. The advantages which these improvements will confer can hardly be estimated. It will undoubtedly stimulate trade, for the very fact that there exists the means of rapidly leaving that city will induce many to visit the metropolis who otherwise would stay away.

A new venture, in the interest of both commerce and humanity, is the introduction of "palace cars" for cattle. Several of these, known as McPherson's palace stock cars, have been put on the trunk roads to New York, and many loads of stock have already arrived in New York in better condition than ever before known. The cattle have the advantage of light, airy and comfortable stalls, and they are abundantly watered and fed on the cars, instead of being removed two or three times to be gorged at filthy stock-yards on the way. The result is that, while each car carries a greater weight of cattle than the old box cars, the shrinkage is found to be some forty per cent. less on arriving at the destination.

On the 27th ult., the contract for the building of the Pittsburgh & Lake Erie Railway was awarded to J. B. McGrann, of Lancaster, Pa., for the sum of $2,500,000. Of this amount, however, only $1,050,000 is to be paid in cash, the contractor taking the first mortgage bonds of the Company to the amount of $1,250,000 and $200,000 in stock of the Company. The contract is for the construction of the entire line between Pittsburgh and Youngstown, Ohio, including the bridge over the Ohio River at Phillipsburg, but not including, however, the bridge across the Monongahela at the Pittsburgh end of the route, where it is to connect with the Baltimore and Ohio Railroad.

The length of the road is sixty-eight miles, and the contract calls for ten per cent. additional roadway for sidings at such points as may be determined upon. The Directors and stockholders are determined that it shall be maintained independent of all other Railway Companies; and although this is not a stipulation of the charter, written articles have been drawn up to be signed by all the stockholders providing that the road shall always be a separate Corporation. Work is to be commenced forthwith by the contractor. It is believed the construction of this road will end the freight discrimination against Pittsburgh.

GAS AND WATER-WORKS.

New gas works are to be constructed at once at Washington, Ind., by St. Louis capitalists.

Peru, Ind., has advertised for proposals for the construction of water works in that city, the bids to be opened Oct 15th.

Little Rock, Ark., has entered into a contract with the Little Rock Water Company of that city for the construction of water works. They are to be completed July 1st, 1878.

The city of Moline, Ill., has contracted with Thomas Yates, of Rock Island, Ill., for the construction of water works. There will be three miles of cast iron pipe which will be furnished by Dennis Long & Company of Louisville, Ky.

Bids were opened in Nashville, Tenn., on the 28th ult., for supplying that city with 2,000 tons of 36 inch cast iron pipe as follows: Jones & Co., Nashville, $30 per ton; D. Giles & Co., Chattanooga, Tenn., $29.25; Dennis Long & Co., Louisville, Ky., $28.75. The contract was awarded to the latter firm.

Messrs. Dean Bros., of Indianapolis, are busily engaged upon the construction of the new pumping machinery for Nashville, Tenn., the contract for which was awarded them some time since. There are to be two sets of duplex pumps, having a combined capacity of raising 10,000,000 gallons, 275 feet high, in 24 hours, made with variable cut off, with independent air pump and condenser. One set of the above will be erected in position in about six weeks, the other in about five months. This firm are also building a single set of the same style of pumps for the Peoria, Ill., water works, capable of raising 4,000,000 gallons, 200 feet high, in twenty-four hours.

MISCELLANEOUS.

The Empire Transportation Company has been purchased by the Pennsylvania Railroad Company.

The Clyde, Scotland, shipbuilders, who have been on strike for six months, have agreed upon arbitration, and will re-ume work immediately.

The Baldwin Locomotive W'ks, near Harrisburg, Pa., have just received an order for several locomotives from a narrow gauge railway in South America.

The indications are that not less than 75 plans for the proposed new State House at Indianapolis, will be submitted to the commissioners. Architects from all the large eastern cities and adjoining states and Missouri intend to enter plans.

As a consequence of the recent partial conflagration of the U. S. Patent Office in Washington, President Hayes has appointed and instructed a commission of architects and engineers to inspect the public buildings in that city, and report what is necessary to render them fire-proof.

A record of the rainfall in South India in 1844 shows that near Cape Comorin, on the West Coast, it was about twenty-six inches; at Trevandrum, it was seventy inches, and at Canamore, 120 inches. At Bombay and farther north, the fall diminished,—the maximum occurring between Cochin and Bombay.

An artesian well, sunk by D. B. Lowell, in Nevada, on Eel River island, at the depth of 120 feet, struck a current of gas which, when ignited, sent up a flame jet thirty-six feet high. A strong wind failed to blow it out, and an eight hours' rain did not extinguish it. In the night a newspaper could be read by its light 100 feet away.

A telegram from Calcutta of Sept. 24th, says: Plenteous rains have fallen in many of the worst famine districts. Agricultural work is active and the crops are making rapid progress. There can be no reasonable doubt that the tide of the great calamity has been turned, but vast numbers of those who survive actual famine must still succumb for their enfeebled condition.

It is said that the famous Eddystone lighthouse is about to fall. It was completed in 1760 and has consequently done nearly one hundred and twenty years' service. The destruction with which it is now said to be threatened is not from any weakness or decay in the structure itself, but in the reef of rock on which it is built which is represented as being ready to crumble away.

For some weeks the Inspector General of the War Department has been examining into the alleged frauds in the disbursement of money in improving Buffalo, Erie, and Cleveland harbors by Colonel Blount, of the Engineer Corps. His report was received at the War Department on Saturday, and is of such a character that Colonel Blount will be relieved from duty and placed under arrest to await court-martial.—*Journal.*

On September 22, at Peoria, Ill., the Board of Supervisors, by a vote of 16 to 7, discharged Wilcox and Miller, architects of the Court House, action being based on the majority report of the investigating committee selected by Wilcox. He charged the contractors with conspiracy to injure his reputation. It is reported that the Building Committee have made a proposition to Boyington, of Chicago, to assume charge of the work.—*Journal.*

There are now, according to the most reliable estimates, from 4,500 to 5,060 boats on the New York State canals, only about 500 of which are rated as first class. From the year 1844 up to the present time the total number of boats registered on the canals was 13,453, of which there were registered in 1874, 203; in 1875, 102; in 1876, 75, and up to the second week in July, 1877, 39, showing a steady and marked falling off in registry each successive year. As stated, the total number of canal boats registered on the canals since the year 1844, is 13,453, but of this number less than two-fifths are now in operation on the canals. The average period of usefulness of a canal boat is about 12 years, and after having been in use five years they are rated as second class.

The Nashville, (Ten.,) *American* of recent date says: "One of the most important works in the country is that of the construction of the new canal around the Muscle Shoals, by which an immense territory will have a ready outlet by water. It will be fourteen miles long, having eight locks. Three locks, about 400 feet in length each, have been completed. The canal is 60 feet wide at the bottom and 80 feet wide at the top, toward which it slants. Each lock costs $175,000. An appropriation of about $800,000 will be necessary to complete it. Should the money be appropriated at the next session of Congress, it is believed the work could be consummated within the next three years. The bed of the old canal is being utilized and the contractor now has between 500 and 600 laborers at work at the shoals. This canal completed, and a water connection thus made between the Tennessee and Coosa rivers, the whole Mississippi Valley and the South would be connected by water, vastly cheapening the transportation of the richest valley on the continent."

Experiments in Europe have proved the success of creosote as a preservative for railroad-ties, bridge-timbers, and wood in other exposed conditions. It saves both from insects and decay. Ties treated in 1840 and piers made in 1850 are still in perfect condition. Works to inject the pores of wood with creosote have been built at South Boston, having a capacity of 40,000 feet of lumber a day. Works have been erected under the patents at Pascagoula, by the New Orleans & Mobile Railroad, for the purpose of protecting their piles against the teredo, which in that locality would honeycomb piles eighteen inches in diameter in two years. At these works most perfect results have been obtained. Piles eighteen inches in diameter and 100 feet long, of yellow pine and cypress, have absorbed on an average more than twelve pounds of oil per cubic foot. The great difficulty is to inject oil successfully when the sap is not thoroughly dried out, but the new process overcomes it. As ties last in this country only six or seven years, the introduction of the creosote process, if as successful as in Europe, must result in a great saving. It is suggested that creosoted wood be used for horse railroad ties and for preserving wooden pavements.

A CORRESPONDENT of the *Chicago Tribune*, Oct 8, states that tile drainage in Illinois is "becoming epidemic," and that, in the past year, tile-making machines have been set at work in nearly every county in the State, and farmers are buying the article by wholesale. Of course there will be a great deal of money and labor lost in the effort of every farmer to be his own engineer, and the effect will naturally be to disgust them with the business, and so to relapse into the old ways of open ditches or no drainage at all.

There must, however, be a large number of well-to-do farmers who have sufficient intelligence and common sense to know that tile-draining, to be effective, requires to be carefully done, and that it is better to pay for the services of a surveyor or engineer who can properly superintend the work than to attempt to do it themselves, and so risk the loss of time, labor and materials involved in failure. We suggest to engineers and surveyors that here is a possible chance for employment, and that a due amount of enterprise in looking after business, similar to that of a merchant or manufacturer, might result in fostering a much-needed improvement in the condition of farming lands and in furnishing employment to a considerable number of people.

We are led to make these suggestions by reason of the large number of inquiries from engineers which we receive in regard to the chances of obtaining employment, and to which we have usually only the most discouraging replies to offer. The tendency of the profession is to look to the large cities for business, as it is there that large public works are projected and where the schemes for engineering projects are usually originated. At present, however, we cannot conceive of a more disheartening undertaking than for a young and inexperienced engineer to start out in any of the great cities in the Union in search of employment. By reason of some unlooked-for accident he may find a situation, but the chances are all against him, and unless he has means to sustain himself indefinitely, and courage and hope to bear him up against the discouragements, he had much better remain at home, or in any kind of employment which he can obtain to support him until the returning tide of prosperity once more sets the money and enterprise in motion that will result in increased demand for engineering talent.

But while there are few if any openings for engineers in the cities, we would ask, Have all other avenues to employment been thoroughly explored and occupied? We have referred to this subject of farm drainage. It is really an immense field if the people who are mostly interested can be induced to see its advantages and benefits. But the staid, hardworking, economical agriculturists will not see through the big figures of the high toned "Drainage Engineer" who will have to depend on Park Commissioners or large speculative companies for his income. We make no suggestions as to *how* this work is to be obtained; if a man has not the energy and tact sufficient to find out for himself no instructions will assist him.

THERE is a steady growing demand for improved sanitary conditions in our large towns, and villages, and there is business for engineers who are posted on the subjects of water works, gas works, and sewerage. Our weekly clippings from exchanges show this to be the case, and we would like to be able to point out to our many friends in the profession just where to look for the needed employment; we cannot however do better than to collect all the information we can on the subject of public improvements and after publishing them leave it to our readers to make the best use they can of the information.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 77th regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, on Tuesday, October 2nd, President W. Sooy Smith in the chair.

There were present: Gen. W. Sooy Smith, E. L. Chesbrough, B. Williams, L. P. Morehouse, E. Hemberle, S. T. Emerson, W. S. McHarg, H. C. Nutt, S. G. Artingstall, C. W. Durham, A. M. Paige, K. F. Booth, E. H. Mott, B. H. Bryant, John W. Weston, Geo. H. Frost, Fred'k. W. Clark.

New members proposed: Edward Hemberle and H. A. Rust.

The secretary read the minutes of the last meeting, and also the minutes of the annual meeting, the reading of which had been postponed to the present occasion.

The secretary reported the following donation to the library: Pamphlet, by Chas. E. Emery, on the Trial of the Steam Machinery of the U. S. Revenue Steamer "Gallatin," etc.

The paper for the evening, on the "Method of Determining the Direction and Speed of River Currents," was read by Mr. S. T. Emerson, of St. Louis.

After the reading of the paper, the president introduced Mr. Edward Hemberle, Chief Engineer of the American Bridge Company, who gave a minute description of the wreck of the Omaha bridge, which took place a few weeks back. He also freely presented his theories on the probable cause of the accident, adduced from careful investigations on the spot. The subject of Mr. Hemberle's remarks provoked much active discussion among the members present.

At the close of Mr. Hemberle's remarks the meeting adjourned.

REPORT ON VARIOUS METHODS OF CONSOLIDATING EARTH THAT HAS SLIPPED.

BY M. COMOY,

Inspector General (Retired) of Ponts et Chaussees.

Translated for ENGINEERING NEWS by Brevet Col. Wm. E. MERRILL, U. S. A.

(*Continued from page 273.*)

2d.—Remarks on the works described in the preceding chapter, omitting reservoir embankments.

The works for repairing slides which I have described in the preceding chapter belong to two entirely different systems.

In one of these systems the broken masses are divided into a certain number of compartments by means of transversal partition walls which cut right through.

In the other system a direct resistance is made to the entire mass in motion, by means of retaining walls built at the foot of the slip.

The first system is most often used. It is in this way that they repaired the slips of the hill-sides of Vichy, of Avrilly, and of La Négresse, and all slides that happened in the cuts and fills of the Lyons net-work of railroads.

In this method of repair the blind drains which serve as transversal partitions provide a ready flow to the enclosed water which caused the slip and which may cause it to re-occur.

Moreover, these blind drains by dividing the mass of slipping earth have the advantage of localizing the movements that may reappear, and especially of very greatly lessening the dragging power which the different slices of earth exert on each other, as I have said above. The dragging power of a mass of earth in motion is certainly lessened by the construction of transversal cuts, and it may justly be said that the mass of earth is enervated by these cuts.

The transversal partitions of dry stone have the most marked effect when they cut through the whole of the broken mass and rest on earth that has not taken part in the movement, and when they extend up to the surface of the slope, as is the practice in the cuts of the Lyons net-work of railroads; or when the cuts at least remain open above the stone fillings, as was the case on the Avrilly hillside. In both cases the solidarity of the earth in the different compartments is entirely destroyed.

In the examples which I have quoted these conditions have not always been fulfilled.

At the hill-side of La Négresse it is very probable, as I have already stated, that the surface of sliding passes below the bottom of the trench.

Nevertheless this work has given satisfactory results. This is undoubtedly due to the fact that the blind drains secure as completely as possible the discharge of the enclosed water, and do not permit it to penetrate to the surface of sliding; thus cohesion is finally re-established between the moving and the stationary earth.

At the Allier hill-side, as also at that of La Négresse the cuts were not filled with stone for their entire depth, and the voids above the stone were filled. This filling has not compromised the success of the works, which is doubtless due to the fact that the enclosed water, finding an easy discharge through the drains at the lowest part of the slip, can no longer soften the earth above.

We may conclude from these examples that the essential point is to secure a sure discharge for the interior waters by means of transversal blind drains, and that when this result is well assured it is permissible in exceptional cases either not to carry the bottom of the drains down to earth that has not shared in the sliding, in cases where it would be impossible or very difficult to do so, it being understood that this bottom must always be placed as low as circumstances will permit in order to leave below the drains as thin a stratum as possible of earth that has been moved; or else not to make the depth of stone filling as deep as the trenches and to fill up the trenches above the filling.

But whenever it is practicable to bed the drains on solid earth throughout their length and to raise the filling to the surface, it is desirable to comply with these two conditions which increase the chances of success.

Although what I have just said applies to all slips either in fills or hillsides or in cuttings, it is particularly applicable to the latter. Slips in the side slopes of hills call for some special remarks.

In the example which I have given of works of repair of this kind, it is supposed that the two slopes of the embankment have slipped at the same time.

In the Lyons net work of railroads the same profile is used for the blind drains of slips in embankments when only one slope slips, that is to say, the drains do not rest on the surface of sliding, as is the case in slips of the slopes of cuts, but they are carried down through the entire mass of embankments to the solid layers of the natural soil.

By this means we get clear of the damages to the drains which might occur from the settlement of the fill, if they stopped for a foundation at the surface of sliding.

It is well to take this precaution in all fills unless they have been made of earth of very good quality, energetically rammed in horizontal layers. It is indispensable when the fills have been made from one end according to the usual practice in the construction of railroads.

I now come to the second method of repair, which consists in resisting the whole mass of slipping earth by means of retaining walls built at the foot of the slope.

The following are some thoughts in this connection which I find in the previously cited work of M. Collin.

Chief Engineer Girard had given his opinion that it was not advisable to resist the sliding mass for the reason that we neither know this mass, nor the angle at which it has a tendency to move.

M. Collin thinks that M. Girard did not perceive with exactness the nature of the movement of these sliding masses, and that some future day we will be able to determine *a priori* the size of the moving mass and the slope on which it slips. However he did not propose to resist this movement at all times and under all circumstances, for success would often be precarious, and would only be purchased at the price of ruinous sacrifices. M. Collin's decided advice is to resort to the use of inside partition walls of dry stone, dividing the broken earth and assuring its drainage.

We see from actual practice in the example of the Bréval cut that it is possible to stop the movement of slipped earth by means of retaining walls.

The work at this cut, which covered a period of ten years, has given engineers the means of determining by experience the best arrangements for assuring the stability of these walls, and the strength required for them.

I would specially point out in this profile the ingenious arrangement which permits an increase in the resistance of the wall, if that should prove insufficient, by the addition of new counterforts on the exterior between those first built.

But I must say, with M. Collin, that unless special circumstances compel a resort to this method of consolidating slipping slopes, it is always more sure and

unquestionably less expensive to use inside partition walls of dry stone, dividing into a certain number of compartments the mass of slipping earth.

I will terminate what I have to say about the works which are the subject of this sub-division by making a few remarks on the question as to whether we ought to remove all earth broken up by slipping, or preserve it in place.

In the work above-named M. Collin states that as the work of repairing slopes has for its object the withdrawal of the water confined inside, it may happen that in the course of time cohesion is re established between the slipping and the passive mass, and that then there might be no reason to fear that a re-loading at the top of the slip would cause another movement. However, he thinks that it is prudent not to count upon this result, and that all earth put in motion by sliding ought to be removed.

It may be advisable, or even necessary, to cause the entire removal of slipped earth when it has acquired a high degree of fluidity, and has undergone a serious subsidence, or even under more favorable circumstances when it is indispensable to place a heavy reloading at the top of the slide in order to reconstruct the work in the shape desired.

But when the earth has undergone only a moderate movement on account of the slide, and there is no necessity of reloading the soil that slipped, earth that has shared in the movement may be left in place without imprudence. The transversal partition walls which are built in the mass will so lessen the dragg ng power of the slipped earth that it may be retained in place without danger.

This is what was done in all the repairs described in the preceding chapter, and made the subject of this sub division. The engineers contented themselves with removing the earth which impeded the routes injured by the slides, and redressing the broken slopes. The success of these works shows that there is no imprudence in such action.

3d.—Remarks on the works for Consolidating Reservoir Embankments.

In sub-divisions 6 and 7 of the preceding chapter I have given a description of the works for repairing the slides that occurred in the embankments of the Cercey and the Torcy reservoirs. But I must state at once that the analogy between these two works is not complete, and that there is no comparison to be made between them.

At the Cercey embankment the slides appeared spontaneously.

At the Torcy embankment they were started by the weight of the revetment which was constructed in 1832 immediately after the fall of the old paving, and which on account of the necessity of keeping up the supply of feed-water had to be built on the old filling, although the filling was indifferent in quality, and had been disturbed by the fall of the paving.

I again call attention to the facts that the material of the Cercey embankment is argillaceous earth, that the slope was thoroughly consolidated for an average thickness of from 15 to 20 feet, the rest of the mass having simply been pounded and compressed by the passage of vehicles, and that the material of the Torcy embankment, made of sandy earth irregular in quality, appeared to have been very imperfectly rammed.

The conditions at the two places were not the same, and different modes of repair were adopted.

At Cercey the mass was considered as sufficiently firm to support transversal partitions of masonry, and these partitions only descended to the surface of slipping, the earth that had not shared in the movement being cut into steps. The future will inform us whether the fil under the partitions will settle under their weight or not.

At Torcy the material of the embankment was of such bad quality that it became absolutely necessary either to rework it properly, or to become independent of its imperfection by founding on the natural soil the counterforts designed to sustain the revetment. The latter method was the one chosen.

Such in substance are the reasonings on which were based the works for repairing the two embankments.

I have only some brief remarks to make on these works.

At Cercey the transversal partitions were built of masonry in hydraulic mortar. This is a very good plan. Partitions of dry stone would carry the water of the reservoir into the body of the embankment, and in the course of time it would penetrate the argillaceous material of which the embankment is built, and would give rise to new slides.

The retaining wall built at the foot of the embankment between the counterforts, will undoubtedly secure the stability of the embankment.

It may be asked whether when this precaution has been taken, and the mass of sliding earth has been subdivided by transversal partitions, it is necessary to remove all the earth which has shared in the movement, and to undergo the somewhat heavy expense of this rehandling.

At Torcy the inner counterforts are composed of piers connected by arches. This arrangement facilitates the work of construction and lessens its cost The resistance which such counterforts oppose to the sliding of earth ought to be little less than that of solid counterforts.

Lastly, I again call attention to what I said in Chapter I, on the reasons deduced from the bad quality of the fill which caused the multiplication of the fixed points obtained by the piers of the counterforts, especially towards the top of the embankment, where there was most reason for fearing settlement.

The above is what I had to say concerning the works for the repairs of the embankments in question.

But I will not leave this subject without remarking how very desirable it is that we should never be required to do work of this kind.

We cannot avoid slips in the side slopes of cuttings, because they are due to natural causes over which we have no control.

We are resigned to submit to slides in heavy railroad fills when it would have been necessary, in order to avoid them to undergo expenses in making the fill much greater than those for repairing the accidents that may be expected.

But slides in the embankments of reservoirs are so serious on account of the hindrances which they cause to navigation, and especially on account of the frightful consequences that follow the rupture of such works, that nothing should be neglected to keep them absolutely out of danger of such injuries.

I therefore believe that it is not out of place to submit some remarks on the best method of building earthen embankments for reservoirs.

However, I only desire to speak of the manner of making fills of this kind and not at all of the profile or kind of revetment that should be adopted; the latter are technical questions that are not embraced in the compass of this paper.

The conditions to be observed in making the fills of which I speak, may be reduced to two; choice of earth, and manner of ramming.

Argillaceous soils are but little adapted to this kind of work. They are unsuitable, in that in the course of time they allow water to penetrate, no matter what may be their compactness; and on the other hand it is difficult to ram them thoroughly; for these soils, which are very firm when dry, become very slippery when wet, and at such times there is much difficulty in ramming them.

The soil that should be preferred for the construction of reservoir embankments is that which is chiefly composed of silicious sand with at most from 25 to 30 per cent. of clay.

Soil of this kind can be thoroughly rammed and it is scarcely permeable to water.

In one of the most recently built embankments, that of the Montaubry reservoir of the Central Canal, M. Duverger, then chief engineer of the work, did not hesitate to reject earth of inferior quality in the neighborhood of the work, and to cause the earth employed for making this embankment, which has the characteristics that I have just indicated, to be procured at a distance of from 2,000 to 2,500 feet.

Earth in which clay predominates seems to me so defective for making reservoir embankments, that if I had only this kind of earth at command for building such a work, I would give up this method of construction and adopt a masonry dam.

Moreover, the possessing of earth of good quality is not everything in building reservoir embankments; it is further necessary that the earth should be properly rammed.

I will not describe the methods of ramming that should be used; they are sufficiently well known. I will only insist on the necessity of ramming energetically, and with this view of giving a small thickness to the layers of the fill. In the latest embankments on the Central Canal, layers of only 4 inches were used. The result was excellent, and I believe that it is well to adopt this dimension.

Ramming ought to be done with the same force over the whole surface of the successive layers. The homogeneity of the embankment is one of the conditions of its remaining in good condition. A small saving might be made by ramming the outer part of the fill less energetically, but such a proceeding would injure the solidity of the work.

In addition, I cannot insist too strongly on not trusting to the passage of vehicles used in construction as a means of compressing the fill. It is an illusion to believe that these vehicles have any useful effect in compressing the earth They do not go everywhere; and where they do go, they cause a very incomplete compression. Whenever a fill has obtained the required degree of compression vehicles leave no mark on it, and wherever they do leave one we may be sure that the compression is insufficient and will so continue.

4th.—Practical rules to be deduced from the preceding remarks.

From all that precedes we may deduce some practical rules which I will now enunciate.

I will continue to make a distinction between the slips of reservoir embankments, and similar occurrences elsewhere.

Repair of slips other than those of reservoir embankments.

Of the two methods in use for the repair of slips of this kind namely: transversal partition walls of dry stone subdividing the whole mass of earth in motion, and retaining walls built at the foot of damaged slopes, the first has unquestionable advantages over the second in that it lessens the dragging power of the slipping earth, and provides an easy discharge for all the water that penetrates the soil.

The transversal walls, or blind drains, are usually placed at intervals of from 20 to 50 yards, according to the height of the slipping slope and the degree of fluidity of the soil.

They should cut through the mass of earth in motion to its full depth.

When slides take place in natural soils, in hillsides or in cuttings, the drains should rest on earth that has had no part in the movement, and it should be cut into steps for this purpose.

When slides take place in the slopes of fills it is generally advisable to carry the trenches for the partition walls through the whole mass of filling down to the natural soil, on which the stone is then placed.

It is necessary that means should be taken, suited to the localities, to provide for the conveyance away from the works of all the water from inside that flows through the drains.

Whenever it becomes necessary to re-build, in their original shape, the works that have been damaged, it is usual to carry up the stone filling to the surface of the slope. In the opposite case less depth of stone may be used. The trenches above the stone remain empty, as at the Avrilly Hillside, unless some one has an interest in filling them up, which may be done without compromising the success of the work, as is shown by the works on the Vichy hillside.

Finally, as far as possible, rain water is turned away by means of ditches surrounding the slips, and by surface drainage.

After these precautions have been taken, should it be necessary to re-construct the works in their primitive condition, the slipped earth is excavated at its base and replaced in the voids left at the top of the slip.

If it be required, the consolidation of the earth is completed either by building a rock-work or a little dry-stone retaining wall at the foot of the slope, or by constructing between the transversal partitions, horizontal arches extending up to the surface of the slope, and descending to a greater or less depth according to the degree of mobility of the soil.

If local circumstances do not permit the trenches for

the blind drains to go down to the surface of slipping, this would be no reason for giving up the use of transversal partition walls, which are always advantageously facilitating the discharge of the enclosed water. The works on the hillside of the La Négresse show that blind drains constructed under these circumstances may give favorable results. But is is then necessary to make the drains as deep as possible, in order to leave the thinnest possible layer of slipped earth between the bottom of the trench and the surface of sliding.

Such are the conclusions deduced from works of the character of those just described, whose object is to consolidate soils that have slipped by means of transversal partitions.

There are advantages connected with this method of consolidation that cause it to be generally preferred. In addition, it is more economical than the system of building a retaining wall at the foot of the slipping slope.

If the conditions are such that it is thought best to have recourse to the last-named method of consolidation, an ingenious arrangement can be found at the Bréval cut, which enables one to proportion the resistance to the pressure of the slipped earth by increasing or diminishing the spaces between the counterforts on the exterior, or even to repair a mistake in calculation by subsequently placing new counterforts between those that were first built.

Repair of slips of reservoir embankments.

Accidents of this kind are so serious, as I have already remarked, that nothing should be neglected to prevent their occurrence.

There is, therefore, a great importance connected with the question of ascertaining how earthen reservoir embankments should be built so as to be safe from such injuries.

To attain this result the essential conditions that must be observed are to employ in these constructions only earth of excellent quality, and to ram the material with the utmost possible energy.

The earth that should have the preference is that which is chiefly composed of argillaceous sand with a small proportion of clay 25 to 30 per cent. at most.

The fill should be made with thin horizontal layers. In order that the ramming may be sufficiently forcible a thickness of only four inches should be given to these layers.

Ramming should be done with the same force over the whole surface of the embankment. It is especially necessary to be careful not to depend on the passage of vehicles for producing the compression of the earth.

Lastly, it is necessary to keep the water of the reservoir from coming in contact with the earth of the embankment; and whatever arrangement may be adopted for the revetment of the interior slope, this revetment ought to be laid in hydraulic mortar.

These precautions were not always taken in the construction of the embankments of existing reservoirs. Their neglect is undoubtedly the cause of the injuries that have occurred to some of these works, and of those which may happen in the future.

Even in this case, transversal partition walls built into the embankment are the most efficacious means of remedying such injuries.

The partition walls ought to be built with hydraulic mortar in order to avoid the introduction of the water of the reservoir into the body of the embankment.

The shape to be given to these partitions depends on the nature of the accident requiring repair, and on the degree of solidity of the materials of the embankment.

In general, it may be said that as long as there is any doubt as to the solidity of the embankment, it is prudent not to support the transversal partitions on the material of the fill, but to carry them through the mass and found them on the solid natural soil.

PARIS, Nov. 28th, 1874.

ON TUNNEL CONSTRUCTION*

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In March, 1863, during the discussion of a Paper read by Mr. J. G. Fraser, M. Inst. C. E., Sir John Hawkshaw said that tunnelling was "a class of work which often presented great difficulties; and he was quite sure if carefully-prepared accounts were brought forward, of all those modes and processes which engineers had recourse to in constructing the tunnels in this country, it would afford, especially to the younger members of the profession most important and valuable information." The Author trusts that the following contribution to the carrying out of the above suggestion may not be entirely unsuccessful.

*Footnote: *From Proceedings of the Institution of Civil Engineers, London.*

I.—General Notes on Tunnelling.

When the formation line of a railway is at a greater depth below the surface of the ground than 60 feet a tunnel is usually adopted. This rule is affected by many circumstances both of a general and local nature, but principally by geological considerations. If the material be soft the extra excavations and extra cost of land due to flat slopes have to be balanced against the extra lining and timbering for the tunnel; if it be hard rock, where but little, if any, lining and timbering are required, the cost of excavation of the small tunnel section under the disadvantages of confined space and restricted means of conveying away spoil must be weighed against the cost of excavating the larger section of cutting, free from these disadvantages.

In selecting the site for a tunnel the facilities for reaching it by shafts at intermediate points must be considered, especially when rapidity of construction is an object. The closer the shafts the cheaper the excavation will become, and the more rapid will be the rate of progress. There is a point at which the economy in working resulting from a large number of shafts is counterbalanced by their cost, and this point can only be fixed by practice. In long tunnels the shafts are generally 8 to 10 chains apart. Before commencing operations it is usual to sink shafts to determine the nature of the ground with greater accuracy than the ordinary preliminary borings afford. The engineer is thus enabled to ascertain the dip and strike of the strata; the number, direction and general character of faults and fissures, if they occur; and the behavior of the material to be excavated when exposed to the atmosphere. By measuring the rate of accumulation of water in the trial shafts, a rough estimate may be made of the quantity of water likely to be encountered in the construction of the tunnel. Except in the case of quicksands, water is most to be feared in bedded and inclined strata, especially at the lines of division of the various beds. Faults and fissures in hard rock are generally local, and once drained give no further trouble. Tunnels entirely in one homogeneous material, such as clay, are usually the most free from water.

The nature of the ground having been ascertained, the next question for consideration is the section to be adopted. This varies with different strata, is affected by economical considerations, and in long tunnels (especially when air shafts are impracticable) by facility for ventilation.

The best strata for tunnelling are rocks, such as chalk, some kinds of sandstone, &c., which, while being sufficiently hard and durable not to require much lining, are still easily excavated. In hard, homogeneous rocks free from joints, beds, &c., the most economical section may be employed. In bedded rocks, sound and tolerably free from joints, a flat top is sometimes admissible, although the pointed arch, formed by cutting the rock into corbels, as practiced in the construction of the Box tunnel, is preferable. When the rock is much jointed or fissured, but otherwise sound, it is advisable to put in a thin masonry arch resting upon walls of the natural rock; the function of the arch being to prevent pieces falling from the roof. In nearly all such tunnels there are some parts where the rock is weak, and at such places patches of masonry should be built. This is especially necessary in some rocks, which although hard at the time of excavation are yet likely to deteriorate when subjected to the action of the deleterious atmosphere of a tunnel. Some of the tunnels through the Oolitic system on the Great Western railway, which were not originally lined, require constant repair on account of the rock becoming soft and friable.

The form of cross section now usually adopted in unlined and partially lined tunnels is the "horse-shoe," or elliptical curve with a flat base, although the old system of semicircular arch with vertical sides is sometimes employed, being more economical and convenient when the lining is only requisite at intervals. A cross section so designed as to allow a considerable space between the engine funnel and the tunnel crown is well adapted to secure good ventilation.

For tunnels through soft ground a lining is requisite to resist the thrust of the earth, and various forms of cross section dependent on the character and intensity of the pressure are adopted, the principal ones being the simple "horse-shoe" form without invert, the elliptical arch and side walls with broad base and flat segmental invert, and the almost pure circle.

No theoretical rule can be given for determining the shape or strength of the cross section of a tunnel, because it is a case in which the earth-pressure is variable, complicated, and impossible to formulate. In ordinary masonry structures above ground, such as retaining walls, the value of the earth-pressure mainly depends, broadly speaking, upon the angle of repose of the material, and may be deduced therefrom; but in the case of a buried archway the value and character of the earth-pressure is affected by other factors in addition to the angle of repose. A notable instance of this is the London Clay, which together with considerable stability and tenacity possesses the property of swelling or expanding when exposed to the combined action of air and moisture—this property occurs less prominently in several other clay formations. It is in such materials that the engineer finds the greatest obstacles, requiring as they do a slow rate of progress and strong and costly designs.

Various theoretical rules have been given for determining the proper shape and strength of buried archways, but they are, in the Author's opinion, based on incorrect and inadequate data. Taking the ordinary case of a tunnel at a considerable depth, it is stated in Rankine's "Civil Engineering" that the proper form of cross section is an elliptical arch, in which the ratio of the horizontal to the vertical semi-axis is the square root of the horizontal to the vertical pressure of the earth. In order to obtain the values of these pressures they are considered as varying in a fixed ratio, dependent upon the angle of repose of the material. The shape of the ellipse is therefore entirely dependent upon the angle of repose or natural slope; that is to say, upon the greatest angle with the horizon at which a block of a given substance will rest on that substance without sliding. This angle has, within certain limits, a fixed value for every substance, and is governed by the co-efficient of friction, because the experiments for determining its value are necessarily made on open slopes, so that, no matter how great the cohesion of the material, the effect of weathering is ultimately to reduce it to a smooth surface. Here, too, the particles are free to move in a horizontal plane outwards; but the case of a mass of ground approximately level above, indefinitely extended sideways and free to move downwards only, and that into a very confined space, is far different. In this instance the force of cohesion has a considerable value—which, however, unfortunately cannot be measured—while the effect of friction will be to retard the sliding of the particles not in one plane only, but in every plane, and its value will be enormously increased. The rule quoted is, therefore, not generally applicable; because, although approximately true for loose granular substances having a low angle of repose, it fails for all materials having an appreciable degree of cohesion, since in such cases it under-estimates the friction and entirely neglects cohesion. It is impossible to obtain convertible expressions for the special conditions of friction above described, and for the cohesion.

The pressure on a tunnel does not depend, to any great extent, on its depth below the surface. The soil tends to slide down into the excavation of the tunnel in the direction corresponding with the limiting angle of friction or line of greatest stress, but supports itself almost entirely on the vertical plane, so that the ultimate thrust on the tunnel is slight in comparison with its depth below the surface, and if the material has a certain degree of stability it will stand for a time without lining.

All theoretical formulæ suppose the case of a perfectly homogeneous material, but such a material is never met with in practice. If the material be bedded and inclined it will show a superior tendency to slide on the planes of bedding, and a similar tendency will be displayed in jointed or fissured masses. If clay it will

probably be full of nodules, and its stability will be continually varying with the quantity of water it contains, and as this water will be unequally distributed the mass will be strained unequally. Clay, too, has the property of swelling. In order to estimate correctly the nature and extent of the pressures exerted by the superincumbent mass on a buried archway, all these features and influences must be taken into account, and the only possible solution of the problem will then be by actual experiment in the special case and deductions from former practice. The conclusion arrived at accordingly is that no theoretical rules for the designing of tunnel sections can be depended upon.

The elliptical section is adopted extensively in practice, because it is economical both in materials and construction, suits the requirements of the rolling stock, and is well adapted for ventilation.

The author's aim has been to show that, first, the curve of equilibrium for a buried archway cannot be proved to be the elliptic linear arch, because the thrust of a mass of earth pressing into a buried excavation cannot be determined theoretically; and, secondly, that it cannot be an ellipse because the earth-pressure varies in an irregular manner at different points of the extrados. Practically, the line of pressures will alter in form in bad ground at every change in the character of the material as the tunnel is advanced, and the aim of the engineer should be to estimate roughly the form it will take in the forward lengths from observations on the work done, and then, if necessary, modify the cross section by the addition or otherwise of a ring in the crown, invert or sides, in order to keep the curve of equilibrium at a safe distance from the edges of the lining. In other words, the section should vary with its load.

The form of cross section, as before stated, is dependent to some extent on the requirements of the rolling stock. For a double-line tunnel the minimum width allowable at the rail-level is 24 feet, and the side walls must not curve much inwards for a height of 12 feet above this level. In order to adapt the ellipse to these requirements the ratio of the semi-vertical to the semi-horizontal axis is taken as about five to three, and about two-thirds of the ellipse adopted, closed when necessary by a flat segmental invert. When an invert is not employed a broad base must be given to the side walls, and this is also to some extent required in the oval section tunnel with invert, because the angle between the side walls and the invert is too acute to allow of the vertical strains on the side walls being transmitted to the invert. When the invert forms a continuous curve with the side walls, as in the circular section, the necessity for the footings or "skew back" ceases to exist.

Since in most tunnels near the surface, the vertical far exceeds the horizontal pressure of the earth, if a value be obtained for the former and the lining made sufficiently thick to resist that pressure, it will also resist the horizontal pressure, the curves of the section being suitable. The joint plane, which experiences the greatest pressure, is evidently the highest horizontal joint of the side walls. This plane forms the base on which the whole of the pressure due to the mass contained between vertical lines from it and from the crown to the surface is borne. By finding the resistance to crushing of the material, and then making the width of the joint planes sufficient to withstand from two to four times the load, according to the nature of the ground, the width of the tunnel lining is obtained. This is the rule generally given in text books. As the depth increases it becomes less approximate, and at 60 feet ceases to be of value. It should be noted that in the designing of tunnels theory generally errs, as in this last case on the side of strength.

Allusion has been made to the property of swelling in clay. The pressure resulting from this property in some instances far exceeds the commoner pressure due to the weight, and dependent upon the friction and cohesion of the material, and has generally been met by increasing the thickness of the lining. The following is the theoretical argument for the Author's view that this special cause of pressure should be met by a modification of the shape of the tunnel section rather than by extra masonry. The account given of the construction of the Sydenham tunnel will furnish abundant practical proofs of the value of the modification referred to, viz., the circular section.

Experience has shown that in the case of the London Clay the resultant pressure of the various stresses to which the mass is subjected is sensibly normal to the surface pressed. Now most of the stresses are due to the expansibility of the material. This expansion takes place equally in all directions, the clay in this respect resembling a fluid, and its normal pressure is thus accounted for. The curve of equilibrium in the case of normal pressure is a circle, so that both theory and practice point to the suitability of the circular section for the London Clay. It will be shown subsequently that this is also an economical section in comparison with the elliptical one. The smaller the area of cross section the cheaper will the tunnel be, and since the width is fixed by the gauge the only means of effecting a saving is to lower the crown. Economy should never be gained by lessening the thickness of the lining, as this is at the risk of the stability of the structure. There is a limit beyond which the useful effect of increasing the thickness of the lining is more than neutralized by the extra load due to the increased span. This limit is ordinarily about 3 feet. If eight-ring work gives way ten-ring work will give way also. In such a case if the section cannot be improved, resort must be had to a stronger material, such as Staffordshire blue bricks.

TUNNELLING IN THE LONDON CLAY.

Tunneling in soft strata is undoubtedly most difficult. A complete discription of it would far exceed the limits of this Paper, and would be moreover a repetition of the exhaustive account of tunnelling through the Weald Clay and Lower Greensand beds, as exemplified by the Bletchingley and Saltwood tunnels, included in Mr. Simms' treatise.

The Author now proposes to give an account of the somewhat different method of tunnelling in the London Clay, as exemplified by the Sydenham tunnel.

Sydenham Hill, which consists geologically of the upper and lower beds of the London Clay, is pierced in various directions by four tunnels. The first was constructed through the crown of the hill, and now forms part of the London, Brighton, and South Coast railway. This tunnel, probably on account of its position, presented no special features during construction. Next in order of time comes the Sydenham tunnel of the London, Chatham, and Dover railway. This is carried through the eastern slope of the hill at a considerable depth. Finally there are the Paxton and Crescent Wood tunnels of the Crystal Palace and South London Junction railway, carried at a high level over the Sydenham tunnel and through the upper beds of the London Clay. Although not personally engaged, the Author has had special facilities for becoming acquainted with all the operations connected with the construction of the three latter tunnels.

The Sydenham tunnel was driven entirely in the lower beds of the London Clay, a material too well known to require description. It enters the hill from the north through a deep cutting, with slopes of 4 to 1. This approach was carried farther into the hill than would otherwise have been necessary, on account of the material being required for a long bank; and ultimately the tunnel had to be lengthened on account of the slow progress of the cutting. Immediately beyond the south end of the tunnel the railway passes under the main lines of the South-Eastern, and the London, Brighton and South Coast railways, in all nine lines of rails. The construction of the bridge was necessarily a tedious operation, and was only completed when the tunnel was nearly finished. In consequence of these difficulties at the two faces, the tunnel had to be executed almost entirely by means of shafts. These were seven in number, and ranged from 50 to 200 feet in depth. The total length of the tunnel from face to face was 2,200 yards. Of this length 1,967 yards were ordinary tunnel, 159 yards open cut tunnel, and 74 yards covered way under the above-mentioned railways. The shaft-sinking was commenced on the 24th of January, 1861, and all the shafts were completed by the 19th of April following. The Author laid the first brick on the 16th of April 1861; and the last length was keyed-in by Mr. F. T. Turner, M. Inst. C. E., on the 16th of April, 1863. The entire work was thus commenced and finished within a period of two years and three months, which may be fairly considered a rapid rate of progress when the many difficulties encountered are taken into account. The Engineer-in-Chief for the whole work was the late Mr. Joseph Cubitt, Vice President Inst. C. E.; and the contractors were Messrs. Peto and Betts.

Exclusive of the "open cut" work, the tunnel face, and the shafts, the original estimated quantity of brickwork was 44,257 cubic yards. The actual quantities of brickwork as measured at the completion of the work were as follows:

58,973	cubic yards of brickwork in the tunnel.		
13,031	"	" "broken work" cut out.	
11,538	"	" "	rebuilt.

There were 5,436 cubic feet of timber in bars, polings, etc., bricked in; and 24,000 cubic feet, exclusive of centres, used up and destroyed. The whole of this extra work was due to the unexpected pressure encountered; unexpected because it was not observed in the Palace tunnel. The difference in the two tunnels may probably be accounted for by their different positions; the Palace tunnel through the crown, and the Sydenham tunnel through the side of the hill.

No difficulty arose from water in the Sydenham tunnel, in fact, so dry were the workings that during its construction nearly 2½ million gallons of purchased water were conveyed down the shafts by pipes for the use of the bricklayers. The sumps were only emptied occasionally, and the water which accumulated in them was principally from the shafts.

The tunnel was set out in the ordinary manner. Owing to the contour of the ground it was necessary to erect two observatories in order to range the centre line. The brick piers for the transit instruments were built with a central well-hole over centre-line pegs. When the pier was complete the centre was plumbed up this well and marked on a flag-stone covering the top, and from this mark the transit was fixed. Two screw bolts were then leaded into the stone and the instrument screwed down, the holes in the frame being slotted to allow of future readjustment. Two poles were fixed in the centre line, about a mile from either face, as a means of resetting the instruments if they moved. The line was transferred down the shaft in the usual manner.

(To be Continued.)

THE RECENT GULF STORM.

The recent storm which swept over the Gulf of Mexico and country to the North and West of it, was reported to have accomplished great destruction at the Government works at Galveston. Since the storm a thorough examination of the works there has revealed the following facts, which I forward to you for the benefit of such of your readers as may feel interested in the success of that very nove undertaking.

But little damage was done to these works—the total is estimated not to exceed five thousand dollars. No damage whatever was done to the Gabionade on either the inner or the outer bars. About 3,500 feet of gabionade has been laid over the former. This remained entirely undisturbed except to be somewhat settled into the sand. The effect of the storm was to deepen the channel over the inner bar from 16½ feet to 18½ feet.

On the outer bar 3,500 feet of gabions have been laid. This gabionade commenced in six feet of water at a point some distance from shore. These gabions were not moved out of line but had generally settled into the sand about three feet, thereby becoming perfectly solid and immovable.

The line between this gabionade and shore consisted of a *pile jetty*. This was washed out for a distance of about 500 feet, but the sand had been washed into the gap thus made, in such a manner as to form a natural wall making repairs there unnecessary.

The works on the outer bar are, as yet, too incomplete to cause any improvement in the channel.

The stability of the works and their perfect condition after so violent a storm, together with the gratifying results obtained where the work has been sufficiently carried out, leaves little room for doubt that the views expressed by Capt. C. W. Howell, U. S. Engineer, (who projected and is now carrying on the works,) in the paper read by him before the American Society of Civil Engineers, at their convention in New Orleans of April last, will be fully realized if not exceeded.

I regret to add that on page 227, Transactions of the American Society of Civil Engineers for July, 1877, Major Howell is wrongly represented as saying that the velocity of the tidal currents upon which the success of this work depends "is so variable, they can seldom be depended upon to move more than the fine, rounded sand, of which the bars are mainly composed, to a depth of 24 feet."

What he did say and what he meant was, "that their velocity is too variable to more than say of it that it

has seldom been observed *to be less than that required* to move the fine, rounded sand, of which the bars are mainly composed, to a depth of 21 feet." On page 237 of ENGINEERING NEWS, of Sept. 1, this sentence has been correctly printed. But in justice to Major Howell, I cannot forbear calling the attention of your numerous readers, and especially such as are members of the American Society of Civil Engineers, to the error in the publication of the latter's "Transactions," and its proper correction as given above.

J. A. HAYWARD.

THE STERLING BRIDGE.

To the Mayor and Aldermen of the City of Sterling, in the City Council assembled:

Your select committee, to whom was referred the matter of advertising for and receiving proposals for the construction of the piers and abutments of the proposed bridge, would beg leave to submit the following report on the matters before them: That immediately after the bridge election, held August 11th, your committee caused the insertion of the following advertisement in the ENGINEERING NEWS, of Chicago, and the Sterling *Gazette:*

"Proposals will be received by the Bridge Committee of the City of Sterling, Ills., until Tuesday, Sept. 25, 1877, for the superstructure of a bridge across Rock river either iron or wood, or what is known as a combination bridge of iron and wood. Said bridge to be of six spans of one hundred and sixty-four feet in the clear between faces of masonry, with bearings of three and a half feet on each pier and abutment, making the total length of each span one hundred and seventy-one feet. Roadway to be eighteen feet in the clear, with a sidewalk on each side of five feet in the clear. Railing to be three feet four inches above the flooring.

"Bidders to furnish their own plans and specifications, with full and complete strain sheets, giving form and dimensions of each part of the bridge; also a cross section of each principal part.

"The bridge must be of sufficient strength to sustain eighteen hundred pounds to the lineal foot, besides its own weight, with a factor of safety of five. Each bid must give the weight of the bridge per lineal foot.

"The abutments and piers will be about twenty feet high, resting on a rock foundation at the bottom of the river.

"The right is reserved to reject any and all bids.

"W. C. Robinson, E. W. Edson, Cyrenus Beecher, committee."

That in answer to their advertisement your committee has received and opened a number of proposals for said bridge, a schedule of which is attached to this report and is made a part of the same. Your committee would recommend the adoption of *one* of the following described bridges, viz.: Plan No. 4, as submitted by the Wrought Iron Bridge Co., of Canton, O.: "All wrought iron truss bridge at $2,913.32." Plan No. 3 as submitted by Hubbard, Eddy & Smith of Cleveland, O.: Combination truss bridge, with wrought iron needle beams, and with a hand rail with iron posts, of flat bar or gas pipe. $18,057.60."

All of which is respectfully submitted.

W. C. ROBINSON, E. W. EDSON, CYRENUS BEECHER, } Select. Com.

SCHEDULE OF PROPOSALS.

F. S. ILLSLEY & CO., Milwaukee.—Iron.—Design A, iron floor beams and iron hand railing, $7,565.36; design A, wood floor beams and hand railing, $4,309.36; design B, iron floor beams and iron hand railing, $2,701.22; design B, wood floor beams and wood hand railing, $0,032.22.

WM. B. HOWARD, Chicago.—Combination.—Iron floor beams, per foot, $22.90; wood floor beams, $20.90.

COLUMBIA BRIDGE CO., Dayton, O.—Iron.—Spec. 1 $26.97 per foot; 2, $24.40; 3, $24.26; 4, $23.66; 5 $23.93; 6, $23.38; 7, $20.39; 8, $18.79.

PENNA. BRIDGE CO., New Brighton Pa.—Iron.—Specification A, per foot, $31.93; iron, specification B, $25.40; combination, specification A, $23.37; combination, specification B, $22.05.

If wood railing is used in the iron deduct $.50 per foot; if wood beams are used deduct from B 1st and B 2d $1.65, and from A and A $2.

DETROIT BRIDGE & IRON WORKS, Detroit.—Iron.—Plan No. 1, $36; combination, plan No. 2, $25.50. Iron hand railing in both plans. (Weight, 1,600 lbs per foot.)

JAMES GATES & CO., St. Louis.—Iron.—With iron hand railing, $35,700; with wood hand railing, $33,000; combination, with wood hand railing, $25,500.

KEYSTONE BRIDGE CO., Pittsburgh, Pa.—Combination.—With wood floor beams, $24,000; with iron floor beams, $26,766.

N. S. YOUNG, Burlington, Iowa.—Combination.—Per lineal foot, $17.00.

MCMURTRY & CO. Chicago.—No. 1, iron, with wood floor beams, $35,820; No. 2, Iron, with wood floor beams, $31,812. With iron floor beams, add $60 per floor beam of thirty feet in length. Combination as per plan No. 2, $21,840.

KING IRON BRIDGE CO., Cleveland.—Iron.—Spec. No. 1, iron floor beams, per foot, $23.36; spec. No. 1, wood floor beams, $26.36; spec. No. 2, iron floor beams, $25.36; spec. No. 2, wood floor beams, $23.36.

WROUGHT IRON BRIDGE CO., Canton, O.—Plan No. 1, $21,295.42; plan No. 2, $22,030.96; plan No. 3, $22,523.44; plan No. 4, $22,913.31; plan No. 5, $21,-00.00.

SMITH BRIDGE CO., Toledo, Ohio.—Specification A, No. 1, per lineal foot, $30.65; spec. A, No. 2, $29.00; spec. B, No. 1, $18.95; spec. B No. 2, $18.18; spec. C No. 1, $17.5-; spec. C. No. 2, $17.50. From specification A, No. 1, for wood floor beams, deduct $4.25 per lineal foot. For specification B, No. 1, with iron floor beams, add $4.25. From specification A, with wood sidewalk rail and iron beams, deduct $1. Specification B, No. 2, with wood sidewalk rails and iron beams, add $3.25.

HUBBARD, EDDY & SMITH, Cleveland, O.—No 1, wrought iron truss, iron needle beams, per foot $25.70; No. 2, wrought iron truss timber needle beams, $23.20; No. 3, combination truss, wrought iron needle beams, $15.00; No. 4, combination truss, timber needle beams, $14.50; No. 5, Howe truss bridge, complete, with hand rail, $15.70. Flat iron hand rail on cast posts and gas hand rail at $1 per foot additional, or wood hand rail at 30 cents per foot additional.

JAMES J. DALEY, Sterling.—Per his plans and specifications, $32,600.

CLEVELAND BRIDGE CO. & IRON WORKS.—Wrought iron, pointed, 2½ in. oak plank roadway, 2 inch oak plank sidewalks, per foot $30.67.

J. W. SAVIN & CO., Chicago.—Plan No. 1, Howe truss bridge, $17,400; plan No. 2, combination bridge, $13,460; plan No. 3, all iron bridge, $33,500.

SMITH BRIDGE CO. Clinton, Iowa.—Specification A, $28,600; spec. B, $27,800; spec. C, $29,100; spec. D, $18,800; spec. E $20,500.

M. LASSIG, Chicago.—Combination truss, wood floor beams, top cord and end posts covered with galvanized and corrugated iron, $24,100; same with iron floor beams, $27,200; all wrought iron, wood floor beams, $35,200; all wrought iron, iron floor beams, $38,900.

PUBLICATIONS RECEIVED.

The Sanitarian, for October.

Journal Zodtchy, St. Petersburg.

Van Nostrand's Magazine, for October.

Spring Valley Water Works; President's Annual Report for 1877, with accompanying papers.

First Annual Report on the Internal Commerce of the United States, by Joseph Nimmo, Jr., chief of the Division of Internal Commerce. Washington, 1877.

Report on the Progress of Work, Cost of Construction etc., of the Cincinnati Southern R. R., by Thomas D. Lovett, consulting and principal engineer. Nov. 1, 1875.

Electrometers, by J. T. Bottomley, M. A. E., F. R. S. University of Glasgow. MacMillan & Co., London. Jansen, McClurg & Co., Chicago. Price, 20 cents.

This is one of the interesting and valuable series of Science Lectures at South Kensington.

The Sanitary Condition of Dwelling Houses in Town and Country, by George E. Waring, Jr., consulting engineer for Sanitary and Agricultural Works. No. 31 Van Nostrand Science Series. Price, 50 cents. Jansen, McClurg & Co., Chicago.

Report of the Trial of the Steam Machinery of the United States Revenue Steamer 'Galatin;' embodying a summary of the general results of experiments with the U. S. Revenue steamers "Rush," "Dexter," "Dallas," "Gallatin." Chas. E. Emery, consulting engineer, U. S. R. M.

A MANUAL OF THE VERTEBRATES OF THE NORTHERN UNITED STATES, including the District East of the Mississippi river and North of North Carolina and Tennessee, exclusively of Marine Species. By David Starr Jordan, M. S. M. D., Professor of Natural History in N. W. C. University, and in Indiana State Medical College. 1 Vol., 12mo., 342 pages. Chicago: Jansen, McClurg & Co. Price, $2.00.

The above work is a valuable one to any person interested in the subject. Its reception by the many scientific gentlemen under whose notice it has fallen, accords it a high place in Geological literature, both as a work of reference and as a labor saving agent for the use of students. It gives evidence of laborious application on the part of Prof. Jordan in its compilation, and in the work of classification, etc., while the fact that is already admitted as a text book in many colleges, establishes a reputation already bestowed upon it by the well-known scholarship of its author. The book is handsomely bound and does credit to the publishers.

Institute of Civil Engineers:

Street Tramways, by Robinson Souttar.

On an Economical Method of Manufacturing Charcoal for Gunpowder, by George Haycraft, F. C. S., Assoc. Inst. C. E.

The History of the Modern Development of Waterpressure Machinery, by Sir William George Armstrong, C. B., F. R. S., V. P., Inst. C. E.

The appearance of yellow fever in Florida lends fresh interest to the question whether that dreadful disease is of necessarily exotic origin or whether it may find in certain parts of the United States the requisite conditions for its production. With the right solution of this question our sea-coast towns are specially concerned. The sense of security which the prevalence of the doctrine of importation has hitherto inspired, perhaps to our great cost, will be rudely disturbed for readers of the July number of the *American Journal of the Medical Sciences*. The leading article is an official report to the Surgeon General by Surgeon Alfred A. Woodhull, U. S. A., on the causes of the yellow-fever epidemic at Savannah last summer. Surgeon Woodhull was at the time of the outbreak stationed at Oglethorpe Barracks, and he began his investigation as soon as practicable and pursued it with all possible diligence, and arrived at perfectly authentic conclusions as to the course of the disease in the earliest known cases. Himself a believer in the importation theory, he was led by the data which he collected to conclude "(1) that there is no evidence of importation of the yellow fever poison in this epidemic; (2) that, if it was imported, no system of quarantine could have guarded against it; and (3) that the spread and virulence of the epidemic were closely connected with air and soil pollution, whether this pollution be considered as a sufficient explanation of the origin of the disease or not." While it was a very general belief in Savannah that the mischievous agent was the ballast brought in Spanish vessels from Cuba and used for a railway embankment, Surgeon Woodhull shows the baselessness of this opinion, and contends that the open sewer known as the Bilbo Canal was, if not *the* cause, a far more probable cause than any single one that has been suggested. His account of the sanitary conditions of Savannah is of the deepest importance to the inhabitants of that beautiful but ill-regulated city, and is enough to fill even transient visitors with alarm. To go into details of its unpaved streets, defective sewerage, contaminated wells, neglect of garbage, and other filthy practices, would be out of place here; but inasmuch as this recklessness largely arises from confidence in the sandy soil on which the city is built, it may be well (for the benefit of similar foundations) to quote this passage: "Permeable soils like this allow from 60 to 90 per cent. of falling water to penetrate, and also allow effluvia from contained decomposing matter to pass through them for long distances. The cleanliness of sandy places is, therefore, often greater in appearance than in fact; and I believe these characteristics may have an appreciable effect upon the public health." The thoroughness and scientific impartiality of Surgeon Woodhull's report give great weight to his conclusions, and deserve the grateful acknowledgments of a people not accustomed of late to return thanks to U. S. Army officers.—*Nation.*

The Providence, R. I., *Journal* gives the following reminiscence of locomotion: The boiler of the first locomotive ever run on a railroad in America is still in excellent condition, and is used at Carbondale, Pa. This engine, named the Stourbridge Lion from the place of its manufacture, was ordered from England by the Delaware & Hudson Canal Company, while the first English, the Liverpool & Manchester road, was constructing, and while it was yet doubtful whether or not George Stephenson would succeed in persuading its managers to use steam. The assistant engineer of the Canal Company, Mr. Horatio Allen, went to England to examine the question of steam transportation, and returned to this country satisfied that it was destined to revolutionize commerce. He was commissioned to order three locomotives. One of them was landed in New York in May, 1829, and after being exhibited for several weeks to throngs of curious people, it was sent by river and canal to Honesdale, Pa., whence a just completed road sixteen miles long ran to Carbondale, connecting the Lackawanna coal fields with tidewater on the Hudson, by means of the canal. The rails and ties of this rude railway were of hemlock, which, not having been well seasoned, were warped and twisted badly by the time the engine arrived, making the trial very dangerous; the more so that the road crossed the Lackawanna River over a slender hemlock trestle, at the height of a hundred feet. Mr. Allen was not ignorant of his danger, but ambitious of distinction as the first engineer in this country, he dared it, in opposition to many anxious friends, and demonstrated that the new idea was a success. This was on the 8th of August, 1829, two months before the successful trial by Stephenson on an English road. The engine was a complicated affair, covered with rods and joints, and with a huge walking beam. It resembled nothing so much as a huge grasshopper. Mr. Allen and Mr. Jervis, the principal engineer of the canal, who ordered the engine, are yet living in the State of New York.

Negotiations for the speedy construction of the Marquette & Mackinaw R. R. have been so far consummated as to make it certain that the road will be completed within the next two years. The company has made a contract with New York parties, in which it is agreed that the work shall be commenced and pushed forward next year. It is the intention of the contractors to construct the larger part of the line next year, and it is not impossible that considerable preparatory work, such as building of docks, getting out the ties, bridge-timber, etc., may be done the coming winter.

ARCHES;
CONSIDERED GRAPHICALLY.

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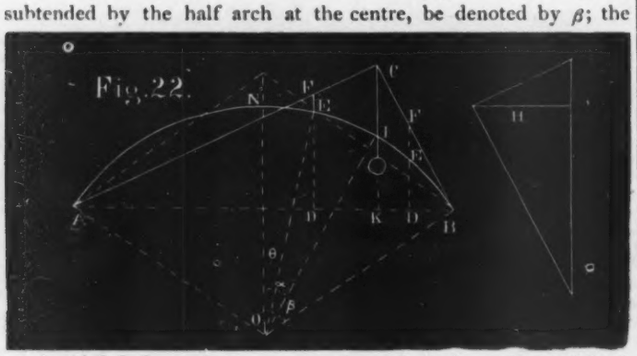
(Continued from page 214.)

The integral of $z\,dx$ between the given limits is the semicircle, while that of $y\,dx$ is the triangle A C B. Substitute the value $\frac{1}{2}\pi r^2$ for the former and $r y_o$ for the second, and we obtain

$$\frac{1}{2}\pi r^2 = r^2 y_o; \quad \text{or} \quad y_o = \frac{1}{2}\pi r = 1{,}5708\, r. \qquad (25.)$$

The ordinate y_o, for a load at any point, on a semicircular rib with hinged ends, is therefore a constant quantity, equal to the length of the half rib. If we draw a horizontal line at this height above the springing, it will contain the vertices of all the curves of equilibrium for single loads.

91. If the arch is segmental, that is, less than a semicircle, we shall use the following notation: Let the angle N O B, Fig. 22, subtended by the half arch at the centre, be denoted by β; the



angle N O I, from the crown to the point where the weight is placed, be denoted by α; and the angle N O E, from the crown to any point where the ordinates D E and E F are measured, be θ. The radius of the arch $= r$, and $ds = r\,d\theta$. If then A C B is the desired curve of equilibrium, C K $= y_o$

We shall have $\quad D E = r(\cos\theta - \cos\beta)$.

$$D F : C K = A D : A K = r(\sin\beta + \sin\theta) : r(\sin\beta + \sin\alpha).$$

$$D F = \frac{\sin\beta + \sin\theta}{\sin\beta + \sin\alpha}\, y_o, \text{ on the left of K;}$$

$$D F = \frac{\sin\beta - \sin\theta}{\sin\beta - \sin\alpha}\, y_o, \text{ on the right of K;}$$

Substituting, as before, in (9.) § 45, $\Sigma D E^2 = \Sigma D E \cdot D F$, we obtain, for the first member of the equation,

$$r^2 \int_{-\beta}^{+\beta} (\cos\theta - \cos\beta)^2\, d\theta = r^2 \int_{-\beta}^{+\beta} (\cos^2\theta - 2\cos\beta\cos\theta + \cos^2\beta)\, d\theta \,*$$

$$= r^2(\beta + 2\beta\cos^2\beta - 3\sin\beta\cos\beta).$$

For the integral of the second member between α and $-\beta$ we have

$$\frac{r^2 y_o}{\sin\beta + \sin\alpha} \int_{-\beta}^{\alpha} (\sin\beta\cos\theta + \sin\theta\cos\theta - \sin\beta\cos\beta - \cos\beta\sin\theta)\, d\theta \,\dagger$$

$$= \frac{r^2 y_o}{\sin\beta + \sin\alpha}(\sin\alpha\sin\beta - \tfrac{1}{2}\cos^2\alpha - \alpha\sin\beta\cos\beta + \cos\alpha\cos\beta + \sin^2\beta - \tfrac{1}{2}\cos^2\beta - \beta\sin\beta\cos\beta).$$

Likewise for the integral of the second member between α and $+\beta$ we have

$$\frac{r^2 y_o}{\sin\beta - \sin\alpha} \int_{\alpha}^{\beta} (\sin\beta\cos\theta - \sin\theta\cos\theta - \sin\beta\cos\beta + \cos\beta\sin\theta)\, d\theta$$

$$= \frac{r^2 y_o}{\sin\beta - \sin\alpha}(\sin^2\beta - \tfrac{1}{2}\cos^2\beta - \beta\sin\beta\cos\beta - \sin\alpha\sin\beta - \tfrac{1}{2}\cos^2\alpha + \alpha\sin\beta\cos\beta + \cos\alpha\cos\beta).$$

These two quantities are to be reduced to a common denominator, added together, and equated with the first member. We can then obtain the value of y_o, which can be easily put in the form

$$y_o = r\,\frac{(\sin^2\beta - \sin^2\alpha)\left(\beta\,\frac{1 + 2\cos^2\beta}{\sin\beta} - 3\cos\beta\right)}{(\sin^2\beta - \sin^2\alpha) + 2\cos\beta(\alpha\sin\alpha + \cos\alpha - \beta\sin\beta - \cos\beta)}. \qquad (26).$$

* $\int \cos^2\theta\, d\theta = \frac{\theta + \sin\theta\cos\theta}{2}$; $\cos - \beta = \cos\beta$; $\sin - \beta = -\sin\beta$.

† $\int \sin\theta\cos\theta\, d\theta = -\frac{1}{2}\cos^2\theta$.

If the arch is a semi-circle, $\beta = 90° = \frac{1}{2}\pi$, and this value reduces to (25.) $y_o = \frac{1}{2}\pi r$.

92. The work of computing y^o, in (26.), for different values of α is not great, as, for a given arch β is constant and the second factor of the numerator is a constant quantity. Since a segmental arch may subtend any angle, it is not worth while to go into the computation here of values of y_o for a given value of β, but as examples of y_o, we will give:

If $\beta = 45°$ and $\alpha = 0°$, then $y_o = .39\, r$ nearly.
" $45°$ " $30°$, " $.42\, r$ "
" $60°$ " $30°$ " $.71\, r$.

All that one needs for the calculation from this formula is an ordinary table of natural sines and cosines. The angles or arcs β and α are to be expressed in lengths of arc, which subtend the given number of degrees, to radius unity. The arc for one degree being $\frac{\pi}{180}$, or 0.017453, any other arc will be obtained by multiplying this quantity by the number of degrees which the arc subtends, minutes being expressed as a decimal p rt of a degree.

93. When the value of y_o is determined we can readily draw the stress diagram of Fig 22 and find the value of H; or the formula proved before, (12.) § 46, applies here, and is easily converted into the second form,

$$H = \frac{W}{y_o} \cdot \frac{c^2 - b^2}{2c} = \frac{(\sin^2\beta - \sin^2\alpha)}{2\sin\beta} \cdot \frac{r\,W}{y_o} \qquad (27.)$$

If calculations have been made with (26.) the quantities desired for (27.) are already at hand.

Then the ordinate at each point of division, by which H is to be multiplied to give M for that point, will be, from § 91, if θ is the angle between the two radii from the crown and the point E

$$E F = D F - D E = y_o \frac{\sin\beta \pm \sin\theta}{\sin\beta \pm \sin\alpha} - r(\cos\theta - \cos\beta). \qquad (28.)$$

The plus sign is to be used for points between the weight and the farther abutment, and the minus sign between the weight and the nearer abutment. We must remember, however, that, if θ is measured from the crown to the right as the positive direction, all angles θ on the left of the crown will be negative, and the *sine* will be minus. If E F is plus it gives a positive bending moment, tending to make the arch less convex, and *vice versa*.

(To be continued.)

METHOD OF DETERMINING THE DIRECTION AND SPEED OF RIVER CURRENTS.*

Having been called upon, in connection with my other duties on the Illinois Central Railroad several years ago, to make a survey of the Mississippi river at Dubuque for a railroad bridge, and not being satisfied with the different methods suggested at that time to determine the direction of the current and the velocity of the same, I hit upon the following—new to me, and I think, also to the profession. The method consists simply in triangulating from established points on the shore to a buoy in motion, and the details of the operation are as follows:

As the first step I made a survey of the shore line of the river locating the triangulation points at the most favorable points for observation, and as nearly as possible opposite to each other, and at right angles to the shore or general direction of the current. This having been done, and the shore line correctly defined, we come to the survey of the current. In detailing the method, I have thought it best to describe the instruments and devices used for the reason, that they were so simple that they can be improvised by any engineer at any place where it may become necessary to make such a survey. With the single exception of the buoy, the other instruments and implements are at hand in all parties in the field. The buoy consists of a piece of pine timber from three to five feet in length and painted. A bolt with thread and nut should be inserted into one end, and this of sufficient length to hold cast-iron washers enough to cause the buoy to sink its entire length in the water; into the other end a short flag staff should be inserted capped with a tin cone or anything else which will render the same easily distinguishable.

A buoy constructed in this way will not be easily affected by winds or waves, and will soon acquire in the water a speed equal to that of the current, is light and easily handled, and will require but one man to throw it out or take it into the boat. This is the only implement necessary outside of the regular outfit of an engineering party detailed to make a hydrographic survey.

To make observation two transits and transitmen, two signalmen and one watchman or time-keeper are required, as also a skiff or light row-boat manned by two men—the one to handle the boat, and the other to take in or throw out the buoy. As a considerable time is necessarily lost after the buoy is taken up until

* Paper read before the Civil Engineers' Club of the Northwest October 2d, 1877, by S. T. Emerson, C. E.

it is again thrown out up stream, two or more boats and as many buoys can be used to advantage.

Everything being in readiness, the next step to be taken is to arrange the operation and take the observations; to accomplish which one transitman with his signalman should be sent to the opposite side of the river with instruction to set up his instrument upon a determined triangulation point, leaving a transitman with his signalman and time-keeper, who should, in the mean time, place his instrument in position over a point previously established. The duties of the transitmen are; first, having set their instruments with back sights upon each other at 0, to move them upon and follow the buoy, which has been thrown over into the river at say from 1000 to 2000 feet above the observer; the time-keeper, with watch in hand, should, as soon as the second-hand approached within some five seconds of the initial point of the minute, repeat "Are you ready?" at which the signalman at his side should bring his flag, which before had been trailing upon the ground, to a vertical position — this would be indicated by the signalman on the opposite side of the river by "ready," and both transitmen should then keep their line of observation upon and follow the buoy. As the second-hand approached within three seconds of the starting point of the minute, the time-keeper should count deliberately, one,—two —three, the last terminating with the minute; his accompanying signal man, at the word "one," waving his flag to the left, at "two" to the right, and at "three" to a vertical position, giving the signalman on the opposite side of the river opportunity to count in time. At the word "three" both transitmen should stop moving their instruments upon their plates and observe and record the readings of their vernier. This, platted upon the map, will give very closely the position of the buoy at that identical second of time. This operation should and can be repeated every sixty seconds, as that time gives ample opportunity to read and record the observations, and should be continued until such time as the buoy gets to a point down stream unfavorable for observation, when the boatman should be signalled to take it in and return up stream for a repetition. My directions were that the buoy should be thrown overboard at constantly increasing distances from the governing shore so as to cover the entire river with observations. This is certainly a very correct way of arriving at the direction of the current, as, in my experience, I found that the buoy was very delicately deflected by projecting points in the shore line, by sand-bars or shallows and was effected by the junction or confluence of creeks or other small streams. It may be objected to on the ground that signals given upon the governing shore will not be repeated on the other at the same identical second of time. Admitting this to be, as it is, the fact, still you arrive at practically the same result as the current lines by the observation become established upon the map on lines parallel to and but a short distance from the reality. It will be readily seen that should observations be taken at different stages of water, and at each different stage be represented by different colored lines the variable action of high and low water can be readily determined. This, then, becomes an interesting study besides enabling the engineer to so locate his bridge piers as to present the least possible obstacle to the current and to navigation.

As the intersection of the lines upon the map indicate observations taken every minute, calculation or a scale will give the speed of the current.

General Intelligence.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Baltimore and Ohio railroad bridge at Cambridge was burned Saturday afternoon last. The fire originated from the spark of a passing engine.

It is proposed to build a bridge across the Maumee river just above Toledo, which will be 2419 feet in length and will cost $55,000.

The Central Hudson railroad officials are engaged in putting iron bridges over all culverts and sluices along the road in the Mohawk valley.

The railroad bridge over the Gatineau River, Ottawa, Canada, is finished and painting all done. The stringers are laid across ready for the rails.

The new bridge over the Connecticut at Springfield Conn., is to be built where the present ferry is. The bridge will be an open iron lattice structure, 1,312 feet long and 20 feet wide, with seven piers, and the estimated cost of the masonry, superstructure and approaches is $90,000.

Villeroy Palmer has been duly appointed and qualified by the Hamilton Probate Court, Assignee of the Cincinnati Bridge Co., a manufacturing corporation under the laws of Ohio. The Creditors of said company are requested to present their claims, duly proved within the time required by law, to the above gentleman, at the office of Logan & Randell, attorneys, 72 West Third street, Cincinnati, for allowance or rejection.

The Columbus Bridge Works of Dayton, Ohio, D. H. & C. C. Morrison, proprietors, have now been in operation for upwards of forty years, and during that entire time have never had a single accident occur to any of their structures through any fault of manufacture, and have never had a bridge rejected.

A force of seventy-five bridge builders, under the direction of Superintendent Ellison, and distributed into three gangs, are relaying the wagon and foot passenger tracks of the Newport bridge over the Ohio River. While this work is in progress only one side of the bridge will be used for wagons and passengers going both ways. The new floor will be of heavy seasoned oak lumber, double courses, and securely spiked. The gauge of the iron wagon track is to be altered in order to make it of use for street cars. The work upon the bridge will be pushed forward as rapidly as possible, and will be completed within a few days.

GAS AND WATER-WORKS.

Lansing, Michigan, talks of introducing the Holly water-works system.

The New York authorities have resolved that hereafter no water-pipes of less than ten inches in diameter shall be laid anywhere in that city.

Brooklyn is threatened with a short supply of water. There were, a few days ago, only fourteen days' supply in the storage reservoir, and economy is ordered.

In the island of Sardinia, long neglected by modern civilization, water and gas works were recently introduced in several small towns amid an enthusiastic display of flags and fireworks.

Boston is importing her gas coal from England, for the first time in five years, refusing to submit to the bituminous monopoly. A Red Star steamer has arrived with sixteen hundred tons.

The committee appointed to solicit subscriptions to stock for building water-works at Keokuk, Iowa, are meeting with great success, which promises to result in the inauguration of a water-works system for that city.

The Consumers' Gas Company, Baltimore, expect to furnish gas in about two weeks. They have fifty-four miles of pipe down, and are now putting up the spans on Monument and Cranby streets to carry the mains across Jones' Falls.

The water supply in the city reservoir, Worcester, Mass., is becoming reduced, and unless copious rains come within the next two weeks pumping will be resorted to. No famine is apprehended, but the autumnal rains are looked for with some anxiety.

The extension of the water main across the river at Cedar Rapids, Iowa, has been completed. Some delay was met with in the shape of an injunction by Major May, preventing their crossing one of his lots. But a purse of seventy-five dollars molified his grievance and the work proceeded.

The drought is quite severe in the region of Providence, R. I. Cisterns, wells and springs have failed, and the manufacturing streams are suffering, although most of the large mills are provided with auxiliary steam power. The roads are very dusty. But the Pawtuxet flows under the streets and rises in the homes and workshops, from full reservoirs and with unfailing abundance.

The Water Commissioners, of San Francisco, Cal., held another meeting lately and listened to supplementary arguments bearing on the scheme to bring water to the city by tunnelling the Golden Gate. So far as the cost goes, this scheme is said to be cheaper than any other presented to the Commission. It is now reported that the negotiations have been narrowed down to two propositions, presumably Blue Lakes and Feather river. The Commissioners are approaching the end of their labors, and will submit a report before many days.

We clip from an exchange the following brief description of a project—which certainly has the charm of novelty—for illuminating the city of San Francisco by night: "They intend to rig up a sort of artificial sun for night use, which is no less than a stationary balloon suspended over the center of the city. From this a powerful electric light and a gigantic reflector will flood the streets with a light that is warranted to be as brilliant as the noon day sun. The project, it is claimed, will cost only half the amount required for the present method of illumination."

The water supply of New York City is seriously affected by the drought in the Croton region and adjoining country. The light September rain-fall has been entirely absorbed by the parched ground, leaving none to run into the streams. Ninety-three days elapsed without any water running over the Croton dam into the Hudson river. For some time past large drafts have been made upon the artificial and natural reservoirs of the Croton districts, every available lake having been put under contribution for the purpose of supplying the city. The commissioner of public works has notified the citizens that the greatest economy in the use of water is imperative. The police department has been instructed to use the utmost vigilance in suppressing waste. The calamity of water famine impends unless there is a large rain-fall soon.

RAILROADS.

The Railroad in West Deering, N. H., is all ready for the rails.

The Montreal, Ottawa & Western R. R. will be running as far as Hull shortly.

The rolling stock of the Bee Line comprises 156 engines and fully 4,000 cars.

Davenport, Iowa, is talking up a tramway to connect with Rock Island and Moline.

The Louisville, Cincinnati & Lexington R. R. was sold, Oct. 1, to its second mortgage bondholders.

The New York Elevated R. R. carried 91,000 passengers more last month than for the corresponding period last year.

An English railway, the London & Northwestern, employs nearly 45,000 men. Imagine that vast army on a strike.

The construction of the line of the New Brunswick R. R. from Grand Falls to Edmonton, Canada, is to be proceeded with at once.

The first engine for the Lake Simcoe Junction R. R. Ontario, arrived at Sutton, and was enthusiastically received by the inhabitants.

A tramway over the portage between Lake Winnipeg and the navigable waters of the Saskatchewan will be fully completed this week.

The Columbus, McArthur & Gallipolis R. R. Company, Ohio, have completed the survey west as far as Lockbourne, Franklin county.

The relatives of the heirs of 65 out of the 81 victims of the Ashtabula bridge disaster, last winter, have settled with the railroad company.

The annual report of the Michigan Central R. R. shows the earnings to be $6,498,.26; operating expenses, $1,706,442, a decrease in the net earnings of $2 6,377.

Montreal has secured a new avenue of communication with Boston and New York in the Portland & Boston R. R. It is believed that the line will develop a large local and through traffic.

The construction of the Victoria Railway extension from Kinmount to Haliburton, Canada, is being pushed forward with all possible vigor, nearly 400 men being at work on various parts of the line.

The Northern Pacific R. R. broke ground at Government Point, on the Arsenal grounds, Benicia, Cal., for the extension of their road to a junction with the California Pacific at Suisun. They have three hundred Chinamen employed.

D. H. Gard, superintendent of telegraph on the Columbus & Hocking Valley R. R., Ohio, has been arranging to have wires put up along the Creek and Snow Fork branches of that road. These branches are rapidly approaching completion.

For some time past there has been a prospect on foot to secure the location of the Wapello machine shops, belonging to the Illinois Central R. R. at Clinton Iowa, and the road has now promised to make the change if the people of Clinton will contribute $100,000 towards the expenses of removal.

A circular recently issued by a Georgia banker says that the new constitution, which will probably be adopted in that State in December, provides that the railways owned by Georgia are valued at, at least, seven millions of dollars, and that, when sold, the proceeds are to be applied to the payment of the State debt.

It is reported that work has actually begun on the narrow-gauge railroad from Martintown, Wisconsin, to the State line. Work on the northern end has been in progress for some time, and the force is sufficient now to construct a mile per day. The Argyle and Cadiz people are confident that they will soon hear the steam whistle.

Mr. M. J. Becker, Chief Engineer of the Pittsburg, Cincinnati & St. Louis R. R. Company, has been absent from his office for several weeks, devoting his entire time to the completion of the Wheeling branch of the Panhandle, to extend from the east end of Steubenville bridge into the city of Wheeling, Ohio. This branch, when completed will give another important feeder to the already comprehensive system of lines owned or controlled by this company.

The Chicago and Northwestern R. R. company now operate 1,993 miles of road and never in its history has

it been managnd so satisfactorily and so profitably to its owners as now, notwithstanding the many drawbacks upon railroad prosperity as compared with former years.

Advices from Fort Yuma says Maj. Dunn, Commandant, has stopped all work on the railroad on the United States reservation, and opened the draw of the bridge to prevent the passage of trains.

The Chicago, Burlington & Quincy R. R. has completed an extension of the branch from Sagetown, Ill., to Keithsburg, which it bought with the St. Louis, Rock Island & Chicago R. R., northward three miles to New Boston, where it connects with the Galva & New Boston Branch. Local trains are now run between Galva and Burlington by way of New Boston.

William H. Vanderbelt, President of the Lake Shore & Michigan Southern, issued a general order to the officers and employés notifying them that an advance of five per cent. upon the compensation of all employés of the company affected by the July reduction of ten per cent, and whose pay amounts to less than two thousand dollars per annum, will be made on and after November 1, 1877.

The managers of the Hannibal and St. Joseph R. R. have nearly concluded a contract with the Vulcan Iron Works, of St. Louis, and the Edgar Thompson Steel Works, at Pittsburg, for the delivery of 2.000 tons of steel rails. In the last two months thirty miles of the road have been relaid and this last contract will give nearly 100 miles of steel rails out of 296 miles, the length of the road.

The Ottawa *Free Press* says:—"We understand the Canada Central R. R. company are willing to sell out their line to Carleton Place to the Toronto & Ottawa R. R. company. This would be a very desirable solution of the railway question and would be greately to the advantage of the new company. It would make the establishment of the workshops in this city a certainty, and enable the company to devote the grant given by Ottawa to be expended among the people who will be taxed for it."

The New Castle, Penn. *Courant* states that the New Castle Ore Company have broken ground for a narrow-gauge road from that city to the great ore beds in the southeastern portion of the county. The road will be about eight miles long, and the intention is to finish it if possible the present year. The building of the road will insure the starting up of the idle furnaces, which will be a great advantage to the city and county, besides developing a vast quantity of mineral wealth.

The Scioto Valley railroad track is completed five miles south of Chillicothe, Ohio, and is laid north from Portsmouth through Piketon, Pike county. This leaves a gap of between twelve and fifteen miles to fill in, which will be laid by the 10th of October, it is said, without fail. The laying of the iron on the southern end of this road has been done under difficulties, from the fact that the road could not be located south of Chillicothe for some time, and all the iron was shipped to Portsmouth and then out on the road. A little delay was caused by the long trestle that had to be built over Indian creek, but these difficulties have been overcome, and the road will soon be in running condition.

The latest returns of the actual receipts and expenditure of the railways and telegraphs in operation in the Japanese Empire, as supplied by the Minister of Finance are for the year 1875, and show the receipts of the Tokio-Yokohama line (eighteen miles) to have been £38,559 and the expenditure £71 334, and the receipts of the Kobe-Osaka line (twenty miles) to have been £50,611, and the expenditure £50 266. The receipts from telegraphs during 1875 were £29.445, and the expenditure £79 909, showing a deficit of £47.461. The expenditure includes the whole preliminary cost of the telegraphic lines, which are being gradually laid down to the chief towns of all the Kens.

J. H. McCartney, chief engineer of the B. M. & C. B. R. R, of Oregon, gives the following facts in regard to the "Thomas and Ruckle Pass." The road summit is 400 feet higher than the Meachem Summit. Phllips creek pass is 125 higher than the road summit The road summit is twelve miles from Summerville and 1,800 feet higher. For eleven miles the ascent is one hundred feet to the mile. On the north the descent is 1,100 feet in a mile and a half. The summit is 3,000 feet above the Umatilla at Weston bridge, which would require 30 miles of road at 100 feet to the mile average grade. James Rinehart and others accompanied the party, and expressed themselves as entirely satisfied with the result of the reconnoisance.

The annual meeting of the Louisville & Nashville R. R. company occurred lately. The old Board of Directors were re elected without opposition. A resolution of congratulation by the stockholders for successful management was unanimously passed. E. D. Standeford was re-elected president, and H. Victor Newcomb vice president. The report of the president shows the affairs of the company to be in a satisfactory condition, the bonded and floating debt having been largely reduced. The earnings of the road are rapidly increasing, being in the past year a net of $2,140,520.28, against $1,484,047.37 in the year before the panic. The road is in fine condition. The country through which it passes is increasing in population and wealth. The company is paying much attention to immigration and manufacturing interests along its line.

Great interest and much anxiety are manifested by the citizens living at and near Point Isabel, where the road will strike and cross the Cumberland river, in regard to the extension of the Cincinnati Southern R. R. at that point, which would seem to be the best and most natural terminus till it can be pushed on to Chattanooga. The distance from Point Isabel to Nashville by the Cumberland river is 400 miles, traveled regularly by steamers landing at some 100 places, many of them considerable towns, which would make Cincinnati their market for selling their produce, buying their supplies, shipping by way of Point Isabel over the Cincinnati Southern road, and the completion of this small portion of the road would add very materially to its revenue. The distance is only three miles, much of the work is already done, and the bridge across the river there is complete, ready for the iron. The estimated cost for finishing this little distance is $ 20,000.

MISCELLANEOUS.

The Canton river, China, has broken through its embankments and flooded miles of country, destroying vast crops.

The Nashua, New Hampshire, Iron and Steel company is making about $74,000 worth of improvements on its steel works.

At Washington on October 4th one half of the marble ceiling of the portico of the Patent Office, on the north side, fell, nobody was hurt.

A new light house for Egg Island, Point des Monts, Canada, is being constructed at Quebec; it will be ready to put in position about the end of next month.

The first telegraph instrument was successfully operated by S. F. B. Morse, the inventor, in 1835, though its utility was not demonstrated to the world until 1844

Capt. Adams and Lieuts. Powell and Lockwood, of the United States Engineers, have arrived at Memphis for the purpose of making a survey of the Mississippi.

Three miles of cars are standing on the tracks at Altoona, Pa. all filled with "scrap" iron from the ruins of round-houses, rolling stock, etc, destroyed by fire in Pittsburg by the rioters.

New surveys are making to ascertain whether the foundation for the Washington monument will bear the additional weight involved in its completion according to the original plan.

The Harrisburg, Pa. Telegraph reports that a large number of meteoric stones have lately been picked up on a farm in Dauphin county, Penn., and that others yet remain in abundance there.

A contract has been awarded Henry Holmes for the grading and metaling of Mitchell avenue, from Clinton Springs to Spring Grove ave., Cincinnati. The estimated cost of this work is between $29,000 and $30,000.

The Chinese government contemplate a partial postal service to be organized and managed by foreigners in the customs department. Postage stamps, it is said, have already been ordered from England. A Chinese steamship company is to be subsidized for carrying the mail along the coast.

The long delayed transfer of the United States Land Office records from the insecure storage in which they had been kept in Chillicothe Ohio, since the abolition of the Land Office at that point, to the office of the Auditor of State, is now in progress under the direction of Mr. C. J. Wetmore, of the Auditor's office.

Mullett, the Architect, alarms the country by saying that the roof of the Capitol at Washington is in just as much danger of entire destruction as was that of the Patent office. The roof is, he says of a similar character and there is just such a man-trap filled with combustible material. Should a fire occur it will be impossible to check it. The authorities would do well to look into the matter.

The Harbor Board, Baltimore held its monthly meeting at the City Hall, Oct. 4, Mayor Latrope in the chair. The report of the Engineer, Major Hutton, showed that Morris & Cummings have completed their contract with the Harbor Board by the removal of 459,000 cubic yards of sediment from the harbor. During last month the firm removed 19 529 cubic yards; Forbes & Co. 106,968, and Daniel Constantine 52,901 yards, making a total in excavations of 179,504 cubic yards of sediment. It was stated that all the contracts would be completed this month or early in November.

Mr. Playfair, the English consul in Algeria, speaks of the eucalyptus trees as being extensively planted in that country. The government encourage its planting, and shares the expense with the communes. The company owning the great iron mines of Mokta el Hadid between 1865 and 1870 planted more than 100,000 of these trees. Formerly it was impossible for their workmen to remain there during the summer; those that attempted it died, and the company were obliged to take the laborers to and from the mines each way. Now, the workmen are able to live all the year through at the scene of their labor.

The Chief of Engineers will name $300,000 as necessary to complete the Chicago harbor, and will ask for $10..000 for the next fiscal year. He asks the same sum to complete the breakwater, and the following among the items for the Northwest: Green Bay $15,000; Ontonagon harbor, $30,000; Fox River, $75,000; Marquette, $25,000; Two Rivers, $20,000; St. Clair Flats, $5,000; Saginaw River, $30,000; Wabash River, $25,000; Toledo. $110.000; South Haven, $25,000; St. Joseph harbor, $31.000; Menominee harbor, $25.00; Port Washington, $12,000.

The Burlington water works are now an assured fact. The contract was signed Oct. 6, the Holly system will be introduced, and the work will be prosecuted during the winter. The thirteen miles of mains will be so distributed as to afford fire protection to the entire city, running out on to the hills and into the suburbs. The buildings and machinery will be situated on the river bank north of the gas-works. Four miles of mains will be put in this fall, and the works be put in running order without delay. Two hundred hydrants will be required and adequate fire protection furnished for all parts of the city.

Messrs. Murray, Dougal & Co., contractors of Milton, Pa., have just completed a bridge over Bald Eagle Creek at Howard, Pa. It is a double cancellated, single span, high truss bridge of eleven panels, with pin connections. Its length is 135 feet, with a clear width of roadway of 16 feet. The height of the truss is 22 feet from centre to centre of chord pins, and the carrying capacity of the bridge is 80 pounds per superficial foot, with a factor of five for safety. It is calculated to support a weight of one hundred tons, and cost $3.500. The design of the bridge and the character of the whole structure are highly commended as reflecting great credit upon the engineer, Wm. H. Law, under whose superintendence it was constructed, and upon the Milton Bridge Co.

An interesting test by hydraulic pressure was recently made at the Harlem Railroad machine shops, in the presence of a large number of railroad men, upon two of the Atwood steel tire railway wheels, the peculiarity of which is that the tire is held to its place upon the centre by a packing of hemp, dispensing entirely with bolts or rivets. For the purposes of experiment, a wheel which had run 40 000 miles, the tire of which showed signs of being slightly loose, was first selected. The experiment was to show that although a tire may work loose it cannot come off, the hemp packing interlocking and securing it beyond the possibility of an accident. The pressure being applied, the tire was seen to start at a pressure of three tons. The pressure being increased up to 24½ tons, caused the wrought iron ring, which is simply used to cover the opening through which the packing is inserted to spring off. When the pressure was further carried up to 50 1-5 tons, it caused the tire to move off 2¾ inches (about half-way off), but still left it firmly fixed to the centre. As a second experiment, a wheel was selected which had also run 40,000 miles, in sound condition. To this a pressure of 63⅞ tons was applied, when the tire showed indications of moving less than one sixteenth of an inch. It was not thought necessary to carry the experiments any further; the demonstration being perfect that tires secured in this way are safe beyond all contingencies.

A set of these wheels, which have during the past winter and summer run 180,000 miles, under a sleeping car weighing thirty tons, have fully demonstrated what is claimed for this wheel, the perfect fastening of a steel tire to an iron centre decreasing the noise and jar and also the wear and tear upon rails and journals.—*N. Y. Daily Bulletin.*

FLORIDA NOTES.

Work is being steadily pushed on the railroad from Indian River to Salt Lake, and it is confidently expected that it will be in running order by the 1st of December. It will be a narrow gauge road with wooden rails.

It has been for some time known that the whole surface of the Everglades is elevated between four and five feet above the waters of the ocean, and the scheme of draining this immense territory has been advanced. There is now some prospect of the realization of the project, as parties in New York, representing abundant capital, have taken hold of the matter and an engineer has been employed for some time in making investigations. This is a subject that will well repay examination, for here are 5,230 square miles of the richest land in the world, capable of raising $300 worth of sugar per acre, without any fertilizers. This land, once drained, would far exceed in value the *polders* of Holland, owing to its semi-tropical position and its adaptability for the raising of bananas, sweet potatoes and all tropical fruits. The report of the engineer making the preliminary survey is looked forward to with lively interest by all Floridians and others who are aware of the capabilities of this region.

The Devils Elbow, a narrow and dangerous channel bordered by coral reefs and oyster banks, in the Mosquito Lagoon, Florida, which has long been an almost insurmountable obstacle to the navigation of the Haul Over Canal and a connection between the Lagoon and Indian river, has been entirely removed by private enterprise. A steamboat company running steamers from New Smryna to the Haul Over Canal, have employed dredges and at a large expense succeeded in rendering the navigation free and safe without any help from the State or National Government. A tramway is to be laid across the narrow isthmus, about 2,000 feet only, at the Haul Over, and freight and passengers transferred to a line of steamers on the Indian river. A new line from Fernandina to New Smryna commenced running.

J. Francis Le Baron.

THE WOODEN PAVEMENTS OF CHICAGO.

The present grade of the streets in the business portion of Chicago is about fourteen feet above low water mark of Lake Michigan, or about eight feet above the average surface of the ground. The streets are either sixty-six or eighty feet wide; the sidewalk allowance in the former is fourteen feet, and in the latter sixteen feet on each side, thus allowing a roadway of thirty-eight or forty-eight feet respectively between curbs. To form the foundation for the paved streets, retaining walls of stone are built at the outside of the sidewalk allowances, and the space between is filled in with earth hauled from the adjacent excavations, and by all the rubbish which can be obtained in the neighborhood. This, of course, is made up of every variety of material, from refuse bricks and stones to manure and kitchen slops. A great deal of material is hauled in the winter and in a frozen condition, and the consequence is that when warm weather comes, the solidification of the accumulated mass is anything but uniform. This accumulation of refuse is the foundation upon which the wooden pavements of Chicago are laid, and it is hardly ever the case that the street is traveled over to any considerable extent before paving, as it is almost impassable, and the residents are clamorous for the completion of the work, as their business interests are very seriously interfered with by delay. The conditions, therefore, for a suitable foundation upon which to lay the pavement are all unfavorable to permanence. The specifications for "Fillings" of the City of Chicago require that they "shall be of sand, clay, earth, or gravel, and free from any animal or vegetable matter, or any perishable material. It shall be compactly put in and well puddled, rammed, and rolled with a roller of not less than five tons weight, and be so firm and compact as to be secure from settling." The facts are, *nothing* is excluded from street fillings; the material is dumped in the most careless way; there is *no* puddling, ramming or rolling; we do not believe the city owns a five-ton roller; and instead of the ground thus formed, being "so firm and compact as to be secure against settling," every citizen of Chicago is knowing to the fact that hardly a pavement is laid that does not show settlement in places before the work has got one hundred yards in advance, and that solidity, instead of being the rule, is the exception. This, then, is the substructure—the foundation—of the Chicago pavements, and they are, from the bottom up, fraudulent. Now for the superstructure. The original Nicholson pavement contemplated an honest foundation of well prepared earth, over which a layer of sand was spread, and upon this boards were laid, and over all the blocks, which were separated by an inch strip and well filled and rammed between with gravel and tar, the layer of boards beneath also being coated with tar. But the city authorities were too mean to pay the royalty to the patentee, and now the following is the specification for the "Paving":

First. A bed of lake shore sand four inches (4) in thickness, laid upon the top of the filling and smoothly rounded to the shape of the street, as per sections in the office of the Board of Public Works, in the book of street improvements, page .. making a part of these specifications. The ballast, sand, etc., to be clean, uniform in character, containing no pebbles of a larger diameter than one inch.

Secondly. Rows of sound, live 4 x 8 inch Norway or white pine blocks, free from sap, loose or rotten knots or other defects, twelve inches (12) long, placed on end upon the sand, the rows running diagonally across the street, and being kept an inch apart. The blocks in the different rows of the pavement to break joints in a similar manner as in brick masonry.

The blocks shall be fitted so as to make close joints, and shall be uniformly laid, not varying in thickness more than a quarter of an inch in the same row. All rot, sap, and other defects to be trimmed off.

The spaces or joints between the rows of blocks shall be filled with clean, bank paving gravel, and compactly tamped down by mean's of a paver's tamping iron, prepared to fit the joints, so that all parts of the same shall be thoroughly rammed. The whole surface shall then be covered with roofing gravel, or gravel screened from that used to fill the spaces between the blocks; said covering to be put on not less than 1½ inches thick, and rolled with a roller of not less than five tons weight, if required.

The "Firstly" cannot well be varied from, except that sand from the nearest excavation is taken when it can be had, thus saving hauling from the lake. In the "secondly," however, the *sound, live* blocks of Norway or white pine, consist of *dead, scorched* pine, brought from the burnt forests of Wisconsin, and when laid in the streets of Chicago the process of decay has already commenced, and to-day any person driving over the wooden pavements laid only two and three years ago does so at imminent peril to his vehicle, so rough and uneven is the roadway. In laying the pavement only the cheapest class of labor is employed, the blocks are thrown in loosely and carelessly, the gravel is rammed in and travel *at once* commences. As we remarked before, a road roller is never seen in Chicago streets; occasionally a stone roller, or an iron one, propelled by two men is run over the blocks. For this class of pavement, on a thirty-eight feet roadway, $2 or $2.50 per lineal foot is assessed on the residents on each side of the street, or the pavement is laid at four and five dollars per foot; the intersections are laid at the expense of the city; the retaining walls and curb-stones are charged to the residents of the street. The average wooden pavement, as laid in Chicago, lasts three to five years so as to be passably pleasant to drive upon, after that it is worse than any corduroy road in the backwoods of the neighboring Dominion. The wooden pavement of Chicago is a standing disgrace to everybody concerned in them; to the city authorities who permit such fraudulent impositions on the heavily-taxed citizens, and who descend to practice the mean and expensive policy of evading the royalty on the original pavement; on the contractors who perform the dishonest work, and on the engineers who permit such foundations and materials to be approved, and lastly on the citizens of Chicago, who are willing to stand idly by and watch the whole dishonest proceeding, and contentedly pay the bills year after year for the worst pavements in America, when a few well-directed efforts on their part would ensure them good ones. There are some hundreds of miles of wooden block pavement in Chicago, and for this city it is undoubtedly the best and most satisfactory that can be had, provided it is properly constructed. But at present there is hardly a dozen miles of wooden pavement in the city that is fit to travel upon, although laid only three to five years ago, and now a committee of the City Council is investigating as to what kind of pavement is best adapted for the renewal of these miles of dishonestly paved streets. With the improvement in the city's financial condition there will be contracts innumerable for street paving, and sewering to be let; and while we would like to see an improvement on the present condition of things, we have but little expectation of there being any. Those of our readers, however, who are interested in paving contracts will do well to get acquainted with this committee, and be on the lookout for some rich pickings in Chicago during the next season.

PERTH WATER WORKS, ONT.

The town of Perth, Co. of Lanark, Ontario, is one of the oldest settlements in the Dominion; it is the County Seat and has a population of perhaps 5,000 people. It is, however, one of the slowest-going, sleepiest towns in the Province, and it is with some interest that we clip from its leading paper, the *Courier*, part of the report of a committee on water supply for the town. The people are "slow but sure," and a recent fire which threatened the destruction of a portion of the place has aroused the "gude folk" and they are going to have water. A public meeting has been called for the 15th, and it is probable that water works will be decided upon, as the people are abundantly able, financially, to undertake the expense. We give details so that contractors may know sufficiently in advance what the conditions are. The following is the report of the committee:

TOWN OF PERTH.

Your committee, having considered the case of the town of Perth, would recommend as the plan to be adopted, if your Council should proceed with the matter, to be as follows:

That a fire-proof engine house be placed on the basin, and that the water be drawn from the main stream of the river. That the works consist of two engines, two pumps, and one boiler, so arranged that either one or both the pumps could be run at once, with a capacity of three to five good fire streams, the test required being four streams eighty feet high—all machinery, pipes, &c., inside building, well under building, and building made a story and a half above the engine room for engineer to live in, 1,500 ft. 8 in. pipe, 1,500 ft. of 6 inch pipe, and 4,750 feet 4 inch pipe, with 14 double hydrants, distributed as follows:

From Harvey to Foster streets on Gore street, as laid down in plan, 8 in. pipe, 1,500 feet. Harvey to Cockburn on Gore, 4 in. pipe, 1,450 feet. Gore to Drummond on Craig 4 in. pipe, 420 feet. Gore to Wilson, up river bed, 4 in. pipe, 560 feet. On Herriott street to Beckwith 4 in. pipe, 800 feet. On Foster Gore to Wilson, 6 in. pipe, 450 feet. On Wilson street to Rock, 4 in. pipe, 600 feet. On Gore Foster to Boulton street, 6 in. pipe, 1050 feet. On D'Arcy, Wilson to Drummond 4 in. pipe, 920 feet.

Hydrants as follows:

At intersection of Boulton and Gore streets; at intersection of D'Arcy and Wilson streets; at intersection of D'Arcy and Drummond streets; at intersection of Foster and Gore streets; at intersection of Foster and Wilson streets; at intersection of Foster and Rock streets; at intersection of Herriott and Gore streets; at intersection of Herriott and Beckwith streets. At the basin: At intersection of Harvey and Gore streets; at intersection Graig and Drummond streets; at intersection Brock and Gore streets; at intersection Cockburn and Gore streets; at intersection of Mill and Wilson streets.

Your committee have sought, by this arrangement, to bring almost every house in the town within 1,000 feet of a hydrant, so as to save the keeping up of a large amount of hose. It covers the ground between Messrs. Allan's and Haggart's mills on the west, and the High School, railway station, and Mr. Berford's house on the east, within a thousand feet; and from Mr. Cromwell's and Mr. Robertson's houses on the north, to Mr. Caldwell's house on the east, while, with the addition of a few hundred feet of the old hose nearly every house within the corporation limits could be reached.

Waterworks of this capacity, your committee believe, can be established at a cost of from $16,000 to $18,000, and perhaps for less, and, by making the debentures payable in one sum at the end of twenty years, the present annual cost need not exceed from $1 to $1.25 per $1,000 of assessment. Thus insuring the citizens against fire for but a small proportion of the amount which they would pay for insurance on one-half the assessed value.

If your Council should think proper to place this scheme before the ratepayers, your committee would advise that it should be done by advertising for tenders accompanied by specifications and plans for such works as are here proposed, complete in every particular and in running order, to be completed by the first day of August next, so that the ratepayers may understand what the final cost would be.

Mr. Charles Meighen estimates the amount of rock to be 900 lineal feet, at an average depth of 2 feet 9 inches below the surface. If the pipes are put 4 feet 6 inches under ground this would give 900 feet of rock 2 feet 6 inches deep. If the pipes are put 5 feet under ground the depth of rock would be 3 feet for the above distance on the average. Extensions of 4 inch pipe, including one hydrant, would cost about $400 per block including the width of one street.

The following comparison of the cost of getting and running a steamer and water-works is made:

First cost of steamer	$5,000
1,000 feet of hose extra	1,250
Engine house and tower	1,500
Hose cart	250
Total	$8,000
First cost of waterworks	$16,000
Annual expenses:	
Interest and principal 15 years, steamer	$800
Engineer and fireman	100
Company	200
Annual cost of extra hose	250
Total	$1,350
Interest only, 20 years, waterworks	$960
Man and expenses	150
Hose company	140
Total	$1,250

Leaving $100 to pay interest on discounting the debentures.

An incidental advantage which has been claimed for water-works is, that from one-fourth to one-third of the total expenditure will be amongst our own mechanics and laboring classes, and that, when once established, the running expenses will be much less than for a steamer, while twice the amount of protection from fire will be given.

All of which is respectfully submitted,

A. J. MATHESON,
W. J. DENNISON,
WM. MCLEOD,
DUNCAN KIPPEN,
H. B. WRIGHT.

Perth Council Chamber, 8th October, 1877.

After a slight discussion the report was adopted.

It is the intention of Sir Allen Young to have the steamer Pandora refitted for another start for the Arctic regions next season. He will probably try the Spitzbergen route.

A *Chicago Tribune* reporter, in an "interview" a few days ago, elicited the following from Jay Gould about his Western railroad enterprises. Said Mr. Gould:

"We have built 184 miles of road from Cheyenne to Denver, to connect with the Union Pacific, and to open up that country to Chicago. We were practically excluded from the Denver Pacific by the high tariffs, hence overcame it by constructing this new road, which will be finished by the 20th of this month. The line runs from Cheyenne to Fort Collins, going south to Longmont, thence to Boulder City, Col., a city of 6,000 inhabitants. Here it connects with the Carriboo mining region, and at Golden connects with a narrow-gauge road which runs through Clear-Creek Canon. The main road follows the base of the Rocky Mountains and opens up several fertile valleys. The narrow-gauge roads run to the Central City, Blackhawk, and Georgetown mines, as rich as any in the State. The roads run South and West, and up grades of 300 feet to the mile, and at Georgetown the track is 8,500 feet above the level of the sea."

We have also got a road in Utah and Montana, leading to Oregon. It is known as the Utah & Northern Railroad. It is constructed ninety miles, and is projected 300 miles further, to Helena City, in Montana."

ON TUNNEL CONSTRUCTION*

BY ARTHUR ERNEST BALDWIN, A. K. C.,
Stud. Inst. C. E.

(*Continued from page 282.*)

Turning now to the progressive construction of the tunnel, the first object for consideration is the shafts. Trial shafts were not made, as it was well known that the material was London Clay. Of the seven working shafts Nos. 2 and 4 were intended for permanent air shafts, and were lined with brick. They were 9 feet in diameter, steined with 9 inches of brickwork laid in cement. The brickwork was carried down within a foot or so of the crown of the tunnel, and the shaft then continued in timber to the level of the invert. Ultimately the timbering was removed and the shaft allowed to rest on the crown of the arch through a permanent stone curb. The shaft was sunk in the following manner:—As soon as a depth of 8 feet was reached a curb was inserted. This curb was made of two thicknesses of 1¾-inch oak, the pieces breaking joint and being bolted together with ¾-inch bolts. Under this curb two oak bearers 9 inches by 6 inches, each about 9 inches from the side of the shaft, were suspended by four iron rods 1¼ inch in diameter, of best Swedish iron. The upper ends of the rods were fixed in transverse timbers 14 inches by 14 inches, and about 30 feet long, resting on double transom pieces placed at a distance of about 10 feet from the shafts at the surface. The curbs and bearers were repeated every 8 feet, the hanging rods in each case being suspended from the bearers next above them. When the bottom of the brickwork was reached the usual short sills were inserted as an extra security; but the system of hanging always worked well. The cost of labor for sinking, steining and hanging the brick shafts was £2 12*s.* per lineal yard, and the rate of progress at each shaft was about 24 lineal yards per month.

The remaining five shafts were of timber, 10 feet across in the direction of the tunnel, and 9 feet wide. There were 16 props of round timber to each setting, and the settings were framed with timbers, 12 inches by 12 inches, placed 2 feet 6 inches apart, the poling boards being 3 inches thick, so that the quantity of timber was about 80 cubic feet per yard in depth. As, however, the shafts were continually giving way under the pressure of the clay, some had to be relined, and all had to be strengthened, and in this way the average amount of timber per yard in depth was increased to 104 cubic feet for the 217 lineal yards of shafts actually sunk. Mr. Simms states that at the Saltwood tunnel the distance apart of the settings was 6 feet, and that this answered very well. Here with a space of 2 feet 6 inches the settings were continually giving way. This fact will give some idea of the nature of the London Clay. The average cost of labor for sinking and timbering only was 48*s.* per lineal yard, and the rate of progress the same as for the brick shafts. The timber shafts were more expensive than the brick ones, on account of the large amount of repairs. The shafts were sunk with jack rolls, horse gins being afterwards erected.

*From Proceedings of the Institution of Civil Engineers, London.

At No. 6 shaft, which was 200 feet deep, it was considered advisable to erect a winding engine, as a horse gin would have hoisted too slowly, when a single skip and rope was found sufficient for the work, on account of the great speed which could be attained. This arrangement unexpectedly proved beneficial in another way, as the constant and rapid journeys of the skip created currents of air in the shafts, and thus effectively ventilated the workings. The use of winding engines for tunnel shafts has now become general, the old-fashioned horse gin being in many cases entirely superseded. It is probable, however that where the depth does exceed 70 feet the horse gin is the more economical machine.

During the construction of the lengths adjoining the shafts there was but little trouble in securing ventilation fresh air being forced down the shaft through a pipe by the ordinary water bellows. When the working faces had reached a point about 150 to 200 feet from the shaft more efficient means of ventilation became necessary. The plan adopted was to sink shafts and to drive headings to connect them with the workings. These headings were driven just below the level of the crown, and were used as working headings. They were timbered and poled in the usual manner, the settings being 2 feet apart. The height outside the timbering was 6 feet; the mean width, 4 feet; the cost, 12*s.* per lineal yard. The air shafts were 5 feet by 3 feet 6 inches outside the timbering; the cost, 12*s.* per lineal yard. The size of the air headings was determined by the requirments of the working heading, which cannot well be made of less dimensions than those given above, on account of the space required for drawing the crown bars.

The expensive system of driving a heading through the tunnel before commencing, as desired by Mr. Simms, etc., was here avoided, and except in the case of the air ways, the heading was never driven more than a few feet in advance of the working face, these few feet serving as a convenient receptacle for miners' tools, etc.

In the system of tunnelling described by Mr. Simms there are two headings, one at the top, and a continuous one at the bottom, for drainage, setting out, etc. A bottom heading was not necessary for setting-out purposes, the practice being to set out the forward work by producing the centre line from fixed points in the completed lengths, which method will be again referred to. It is probable that the use of air shafts, when the tunnel is only of moderate depth, is the most economical mode of ventilation. To force a considerable body of air down the main shaft requires special and expensive plant, and the friction also is very great, because there is not room in a 9-feet shaft for a pipe of other than small diameter. The cost of ventilation by the method of shafts and headings may be taken at little above the cost of sinking the air shafts, viz. 12*s.* per lineal yard, as the timber is small and mostly recoverable. The cost of the air headings may be fairly placed to the account of the general excavation, and not to ventilation. It is impossible to estimate generally the relative cost of the methods of ventilation, because it will vary with the material, the depth of tunnel, etc.

Many engineers hold the opinion that headings, unless unavoidable, should never be used in swelling ground, because they expose a large surface of clay to the air, which results in their giving way after a time, thus loosening the material, and making the mining more expensive. But it is possible to carry this principle too far. If a heading of moderate dimensions be properly timbered and close-poled, it will stand for several months without the timbering or the ground being appreciably affected. Nothing is to be gained by neglecting good ventilation, because swelling ground will swell just as rapidly with foul as with fresh air.

On the other hand, the outlay made to procure good ventilation will, putting aside all Sanitary considerations, be repaid by the prevention of dry rot in the timber.

Five of the shafts were worked by horse gins, and the other two by stationary engines. The skips were of the usual kind, made of elm and bound with iron. They were less than 3 feet by 3 feet at the widest part, so that with steady hauling they easily passed in a 9-feet shaft. They held about ⅗ cubic yard of material, and were moved both above and below on trollies running on lines of 2 feet 1 inch gauge, each trolly taking two skips. When the working face had advanced a considerable distance, the trollies and skips were drawn to and from the shaft by small Welsh ponies.

The shaft lengths averaged 15 feet, and the side and leading lengths 12 feet 6 inches each. The side lengths were completed before the shaft lengths, in the usual manner. Most of the drawing bars and poling boards in the side and shaft lengths were built in. The chief difference between the timbering of the side lengths and the leading length was the use of stretchers instead of rakers. The shaft settings were strengthened where the sills of the shaft faces of the side lengths pressed against them, in order to resist the extra thrust. The mining of the leading lengths was carried on in the usual manner. A crown heading, 6 feet by 4 feet, was driven the distance of each length. The crown bars were then got in, either by drawing them from the previous length, or, if those had to be bricked in, by getting up fresh ones. The near ends of the bars rested on the completed brickwork, and the forward ends (which were considerably raised) on temporary props. All the arch bars were spaced 2 feet 6 inches from centre to centre, those for the sides being rather farther apart. The average diameter of the six crown bars was 18 inches, that of the others varied from 12in. to 10 inches. When a depth of 9 feet had been excavated below the centre bar, the top sill 28 feet long, and 14 inches by 14 inches was inserted, and new props were bedded upon it to support the bars. The props varied from 10 inches to 7 inches in diamater. As the excavation progressed, raking back props were inserted to support the top sill until the middle sill, 30 feet by 14 inches by 14 inches, which was 7 feet 6 inches below the top one, was got into place. Props were then inserted between the two sills. The same process was gone through for the bottom sill, which was 24 feet by 14 inches by 14 inches, placed 7 feet below the middle sill. Lastly, short props were sometimes put under the bottom sill. The bars were kept apart by struts 4 inches to 5 inches in diameter, five rows to the length. The whole face, the roof, and the sides of the length down to the top of the lowest sill were close-poled, with 1½-inch elm or pine boards. Many miners leave spaces between the poling boards even in swelling ground, alleging as a reason that these spaces enable the clay to swell to a certain extent, and so relieve the timbering of a good deal of weight; but on the principle that prevention is better than cure, close-poling is probably a superior plan. The two upper sills were held against the face by rakers 40 feet by 14 inches by 14 inches, and 25 feet by 14 inches by 14 inches respectively, which rested in holes in the finished brickwork, and were provided with cast-iron caps where they abutted against the sills. These rakers were made longer than usual, that their lower ends should press against brickwork that was thoroughly set. For further security, stretchers were inserted between the sills and the finished brickwork. Generally the bars, props and struts were of round larch timber, a wood which has often proved to be the best suited for tunnel work. The sills were in two pieces, scarfed at the centre and bound with iron glands, and they, as well as the rakers, were of best crown Memel or Dantzic. Three sills are unusual except in bad ground, but the timbering generally was exceptionally strong and complete, although far from being too strong, as the event proved. Where the ground was bad, extra bars, rakers, stretchers, etc., were inserted to strengthen weak parts. Thus in some lengths the number of rakers was doubled, and in other cases the bars were put closer together, long stretchers being placed between the crown bars. In getting out the lengths allowance had to be made for the timbering bulging in when the pressure came on. This allowance ranged from 3 inches to 6 inches at the sides, to 1 foot 6 inches at the crown.

Every arrangement was made to take the load off the timbers with the utmost expedition. So soon as the miners had shaped out the invert, the ground moulds and wall profiles were set for the bricklayers, who worked continuously until the invert and walls were up to springing level, when they in turn made way for the centre setters, after whom the brick layers returned to complete the arch. The side bars were taken out one by one as the work progressed, and when the haunch was reached blocks of brickwork were built up

between the crown bars, space being left for drawing the bars.

As there was no continuous heading, the usual mode of setting the ground moulds from fixed points in a permanently ranged centre line could not be resorted to, and, in fact, for the first lengths the centre line was ranged and the ground moulds set simultaneously. This was effected by producing the lines given by the shaft wires with a theodolite, using every precaution to insure accuracy. When the side lengths were completed, permanent points in the centre line were fixed. This process of setting out may appear liable to error, but where there is no continuous heading it is inevitable, and, if carried out with proper care, it is sufficiently accurate. In proof of this it may be stated that, although a length of 200 to 300 feet of the tunnel was in some cases produced from a line only 7 feet long, yet the error at the junctions never exceeded 1 ½ inch.

The centres used in this work were as follows: There were four ribs to each length of 12 feet 6 inches, spaced so that a bricklayer could stand between the inner and outer ones, and reach in between the two inner ones. The leading rib only differed from the rest in being 7 inches thick instead of 5 inches. The butting pieces and cross beams were of oak, and the remainder pine. There was no tie-beam, and the centre could be divided into two parts by unbolting and disconnecting it at the crown. Each of these parts would go through a space less than 8 feet wide, and was of light weight. Each half of the rib was supported by two longitudinal sills, 14 inches by 7 inches, which were carried on uprights 9 inches by 9 inches, bedded in the invert. The setting wedges were of oak. As the foot of the upright nearest the side came on the steep part of the invert, a corbel of brickwork called the "tow- path" was always built to give it a level bearing. The laggings were sometimes 2 inches, at others 3 inches thick. The advantage of the above arrangement over the method of supporting the centres on cross sills resting in holes in the side walls—a plan sometimes adopted in heavy ground—are that time and trouble are saved in setting; no undue strain is put on the side walls while they are "green," and they are, in fact, relieved of a great portion of the weight of the arch, which is temporarily thrown directly on the invert. Besides this, cross sills are always in the way of rakers, etc., and are much heavier to move than the centre timbering above described. The great strength of this centre is evident, and its occasional failure at Sydenham is a proof of the immense strain to which it was subjected. Such a design is unnecessary in ordinary tunnels, where the weight supported rarely exceeds that of the brickwork. In such cases, skeleton ribs, resting on sills propped from the invert, are usually employed.

Two sets of ribs, and some times three, were used at each face, so that the back length remained on the centres until the next length but one was up to springing level. Besides this an extra set was often necessary, as the ribs had to be doubled in bad ground, that is eight ribs were put to one length.

The section originally proposed was modified before many yards of the tunnel had been built. The elliptical form seemed ill suited to the material, for length after length gave way, many yards of brickwork having to be cut out and rebuilt; until at last dearly-bought experience pointed to the suitability of the circular section, after the adoption of which, in April 1862, the work stood firm and progressed far more rapidly. This does not at first appear to be true, because in the ten months from the commencement to the adoption of the circular section about 930 lineal yards of tunnel were built, while the remaining 1,027 lineal yards took fourteen months to complete; but during this time a large portion of the 940 lineal yards had to be cut out and rebuilt.

At first the outer faces of the side walls were inclined inwards, but this plan was soon found to be defective. The first alteration was to widen the base of the side walls; still length after length began to come in at the sides, and the invert was crushed up. To remedy this the invert was lowered. This section answered tolerably well, but gave way in every length where the ground was bad. The next experiment was to do away with the broad bases of the side walls and build the tunnel to a symmetrical oval section. In the lengths built to this section, although the invert stood firm the side walls gave way as usual. The observation of this fact led to the effectual practical solution of the problem. The arch was lowered considerably until the vertical became slightly less than the horizontal diameter, thus giving a nearly circular section which proved capable of resisting every pressure, and never gave way to any extent worthy of record, nearly the whole of the broken work, exceeding 13,000 cubic yards, occuring with the other sections.

The number of rings of brick work in the invert, side walls, and arch varied with the character of the ground in each length, the minimum being six rings and the maximum twelve rings, while the preponderating section, comprising more than half the tunnel, had an eight-ring arch, eight-ring side walls, and seven or eight-ring invert. It is impossible to give the length of the tunnel built to each section, as there was so much variation in the thickness, and so many lengths were cut out or patched.

The quantity of excavation per yard forward in the orignal section, with six-ring walls and arch, and four-ring invert, is 77.25 cubic yards, and of brickwork 22.50 cubic yards per lineal yard forward. The full-line section, with eight-ring arch and side walls and six-ring invert, the excavation amounted to 84.67 cubic yards, and the brickwork to 30 cubic yards. In the section with eight-ring arch and walls, and seven-ring invert the amount of excavation was 78.40 cubic yards, and of brickwork, 27.60 cubic yards. With this section and eight rings throughout the excavation reached 79.25 cubic yards, and the brickwork was 28.44 cubic yards. The average brickwork for the 940 lineal yards of tunnel built to the different sections exclusive of broken work, is 30 cubic yards per yard forward, or 2 cubic yards more than the average section, which proved more efficient. The amount of brickwork in the haunches averaged 4 cubic yards per yard forward, and is extra to the quantities just given. Besides this there is the tow-path and the packing between the bars.

The brickwork was at first built in cement, but after about one-half the tunnel was completed this material was abandoned in favor of blue lias lime, it being considered that the slower-setting mortar would enable the work to take the pressure more gradually, since it made it more elastic. All broken work was executed in cement, as the pressure had generally expended itself before the work was cut out. The cement mortar was made in the proportion of 1 of cement to 3 of sand, and and the lime mortar of 1 of lime to 2 of sand and burnt ballast.

Most of the bricks were made on the ground from the material excavated; and, in order to turn them out with sufficient rapidity, four large yards were established, and machines, and extensive drying sheds erected, so that the operations could be carried on throughout the winter months. Fifty-five million bricks were made in less than three years, at a total average cost of £1 1s. 8d. per thousand—a low price considering the large amount of plant required for winter working. Near No. 4 shaft, one of Messrs. Bradley and Craven's dry clay machines was used. The material was taken direct from the tunnel, a small portion of crushed burnt clay being added. By this system several millions of very strong bricks were made at a net cost of £1 0s. 4d per thousand. At one period, clay brought up No. 4 shaft went down again as bricks in less than a fortnight. Bricks made from the London Clay were rather brittle, but capable of bearing great compressive strain, as the accompanying table will show.

(To be continued.)

HENRY MEIGGS.

Henry Meiggs, the Peruvian Railroad Prince, died at Lima, on the 29th ult. In his taking off the world of romantic financial endeavor loses a hero whose record is unparalleled in the history of business effort. His life was one of glittering successes, dazzling failures, brilliant frauds, and reckless extravagance. In his character he was an anomaly. Thoroughly lacking in principle when his interests were at stake, he was at the same time honest. A close shrewd calculator in his every action, he was also a prodigal. Destitute of any moral nature, he became a god through his lavish generosity. With all the instincts of a hard working man, his preferences were for the every day life of a King. Voluptuous in his tastes, he courted hardships for the pleasure he found in them. In him all extremes centered.

Born in Greene County, New York, in 1811, he in early life developed a facilty for conceiving and executing plans involving heavy monetary interests. The shallow streams of trade had no allurements for him. It was in the broader sea that he found water to float his gigantic schemes. Embarking in the lumber business, he matured arrangements that soon had placed him at the head of that interest but for the crash of 1837, which laid the fabric of his early fortunes in ruin.

He turned his eyes upon California and was pleased. In July, 1849, he landed at San Francisco with a shipload of lumber. His profit on the cargo was $50,000. His profits in experience were millions. Taking a subordinate position in a lumber-yard he studied the situation. San Francisco needed lumber. Contra Costa County would furnish it. He hired 500 men, and and cleared $500,000. California bowed before him, made him her model in politics and in society. When the crisis of 1854 passed over, his worshippers found him to be a forger and an exile. He might have saved himself, but in trying to save his friends he had committed crimes that drove him from the country, but he had paid every personal debt he owed.

The next news of him reported him as Superintendent of Bridges on the Valparaiso & Santiago Railroad in Chili, a road that had ruined every contractor that touched it. There were but thirty-three miles to finish, and they were through solid rock. For $12,000,000 he filled the air with earth and stones, and in two years the road was finished. The highest honors were crowded upon him, and the Chilenos made an idol of him. Peru sought him and he laid railroad lines through swamps, and mountains and storms and earthquakes. His successes were scarcely commensurate with his prodigal style of living. The entertainment he gave on the completion of one road cost upwards of $200,000 in gold. He chartered steamships and extended roads to convey his guests to the banquet. The nabobs of the Republic looked upon his expensive habits with wonder. His wealth was unknown, but along the western coast of South America he was called MONTE CHRISTO, and he put the same energy into his work that EDMOND DANTES put into his vengeance. His residence was the finest in Peru, and his table was always ready for guests, however unexpected and however numerous.

Around Lima was a dilapidated adobe wall, and beyond the wall a weary prairie of refuse. For an interest in the redeemed land he made the waste a flower-garden. The staple product of the Republic had been revolutions. Evolution in office depended upon the financial condition of the "outs." When their Treasury was ruined they routed the "ins," who retaliated when they had expended their stealings. A stable Government was necessary to Meiggs' schemes. When the "cuts" were impoverished he gave them what they wanted from his own means, and they left the Government intact. He inaugurated a system of bribery that paralyzed all opposition. A dangerous man was to him a merchantable article. When the combination became too strong for him he bought the Government.

By expending fortunes he secured contracts for building 1,007 miles of roads, for which he was to receive $126,000,000. These roads all led to his financial Waterloo. For the first time he had miscalculated. They proved failures, and, having absorbed the contract price, forced him upon the market for money. His enemies seized upon the advantage offered, and refused to accept his bills, which became a drug. He bought the Government indorsement and staggered on. His bonds fell on the foreign Bourses, and finally became valueless. The combination formed against him struck blow after blow at his credit. Two strokes of paralysis had weakened him, and a third found him shattered and broken. Exposures of his frauds came thick and swift. His creditors were clamorous, and the poorer were paid to the utmost farthing. It was plain to him that his fortunes had fallen beyond retrieving, and he turned away from the cares and troubles of a life remarkable for its incongruities, its pleasures and anxieties.

He left Peru almost bankrupt through schemes urged upon her as her salvation. His death has created a

financial revolution whose effects will be left after his rails have rusted and his ties rotted away. In his life he taught a peculiar lesson of sagacity, without moral balance; of generosity, without an element of justice; of magnificent frauds built upon a foundation of fair dealing between men.—*Chicago Tribune.*

THE RESPONSIBILITY FOR COMMERCIAL PANICS.

Mr. John Bright has been making a speech, at the opening of a new and magnificent city hall in Manchester, in which he somewhat surprised his audience by the utterance of gloomy forebodings as to the future of British industry. In fact, he asked the Manchester men to bethink themselves of the possibility that the great factories to which they owed their wealth and prosperity would at no very distant day be in ruins, like the old castles of the feudal period, at one of which—Tantallon, the stronghold of the Douglases—a friend had lately suggested to him the very thought which he then reproduced. The agency to which he pointed as likely to bring about this overthrow is the exactions and restlessness of the British workman, which are already, he thought, placing the British manufacturer at a marked disadvantage in comparison with his foreign competitors, and threaten him with the loss of the markets which have been opened with so much labor during the past seventy years, and have been the source of such enormous accumulations of wealth. As Mr. Bright has always hitherto taken a very roseate view of the future of English trade, these misgivings have produced much greater effect coming from him than they would have produced coming from almost any other man in England. It has been somewhat deepened by a letter from Sir Edmund Beckett, a noted parliamentary lawyer, in which he charged trades-unions with being combinations to do less work for the given wages, and with teaching the doctrine that it is the business of workingmen to do no more than the least they can get paid for.

Mr. Thomas Brassey, who is one of the largest employers of labor in England, has, however, combated these views, in a paper read before the Trades-Union Congress at Leicester, on "Work and Wages in 1877." and he makes a defence of the workingmen which has a good deal of bearing on the causes of the hard times in this country as well as in England. He shows by some comparisons between British and Continental, as well as American Workmen, that the Englishman is really no more fretful, unreasonable, or improvident than any of his neighbors, and much less so than some of them—the Belgians and Germans, for instance; but he points out that American workmen not only get higher wages in many important trades than their British competitors, but are apparently "conscious of the necessity of working hard in order to keep up the high wages they are at present earning." He says:

"The United States afford some striking illustrations of the extent to which the influence of a high rate of wages on the cost of production may be neutralized by superior organization, by superior industry in the worker, and by the substitution of mechanical for manual labor. The small arms for the Turkish army have been largely supplied from the United States. The ability of the Americans to compete with the makers in this country in the manufacture of an article in which so much labor is employed is a very significant circumstance."

The cause of the present depression in England and Germany, as well as in this country, he holds to be the enormous errors in judgment of the great managers of capital, as shown in the prodigious overtrading and overproduction of the years between 1865 and 1873; and for this, of course, the workingmen, though they suffer the consequences, can in no way be held responsible. As we now look back, this overproduction certainly seems to have been prodigious. There is hardly any leading branch of industry, either in England or America, which does not *now* seem to have been, seven years ago, adding to the world's stock of goods in a most reckless way. We are bound to say, however, that both in Mr. Brassey's utterances and in most of the homilies one reads here on the causes of the existing depression, there is a great deal of vagueness and unprofitableness. They never point out the signs by which, during the season of buoyancy, producers may know that they are doing too much; and this, after all, would be the only contribution of much value that anybody could make to the discussion. The great industrial activity of periods of inflation is not caused simply by the eagerness of manufacturers to turn out goods: it is caused also by the eagerness of the rest of the public to buy the goods. Trade is kept active just as much by the orders of consumers as by the speculative plans of the manufacturers themselves. The enormous production of railroad iron in this country in 1872—1,000,000 tons—was not the result only of the ironmasters' recklessness or want of judgement; it was also the result of the railroading fever which had taken possession of the whole community, and had turned even ministers and philanthropists into peddlers of worthless stock and bonds. We all see *now* that it was a kind of madness, but this does not say much for our own sagacity. Who was it saw it *then?* What we need in the commercial world is not so much lecturers and preachers to tell us after we have broken our heads that it was all due to our fast driving, as somebody to tell us while driving that at that pace our heads are in danger. Somehow these people do not appear at the right time. At least two-thirds of those who are now explaining "the hard times" were in 1872 showing with much vociferation that hard times would probably never come again. To the producer an active market will always operate as an overpowering stimulus to production, and in fact furnishes him with a reason for producing vigorously of exactly the same nature and force as that which the general dullness of the markets now furnishes him for restricting production, and furnishes the critics for believing that in 1873 he was a fool.

It may be that we shall eventually have men in control of our great accumulations of capital who will be able to take in the whole industrial and commercial field of the globe (with its vast body of delicate, interlacing interests), with so much judgment and perspicacity as to see from a distance the faintest sign of a glut or a collapse, and resist resolutely the temptation of rising prices and the contagion of universal hopefulness. But such men must always be scarce. We have in this country now a large number of persons both in and out of business whose wisdom about the events of the last ten years is great, and who certainly never will be caught again making railroads which are not needed, or producing more cotton or iron than they can sell. But they are mostly people on the wrong side of forty, who before the times again become really "good" will have more or less lost their hold on the reins of business, and have yielded their places to men who know nothing except by tradition or youthful reminiscence of the horrors of the crisis through which we are now passing, and to whom the warnings of their elders will appear simply signs of senile nervousness. It is to this change of men and inevitable change of conditions that we in a large measure owe the recurrence of panics at intervals of about twenty years. In other words, the men who figure in one panic seldom figure in another. Both the deluders and their victims have changed, and the legitimate volume of business has so grown in the natural course of things that the new men think it would be ridiculous to be frightened by the figures which frightened their fathers.

It is therefore, we think, unfortunate to tell workingmen that any class in particular is especially worthy of blame for the commercial crises which cause so much suffering. They are mostly due to a kind of national delirium in which all classes share, and for which it is difficult to suggest any complete remedy, except the ordinary and rather vague one of individual prudence, which however, would be more effective if we did not preach and admire enterprise still more than prudence, although it is enterprise that gets nearly everybody into commercial trouble. Mr. Brassey makes one excellent suggestion to the trades-unions, and that is, that they should pay highly, if necessary, agents possessing capitalists' or manufacturers' knowledge of the markets at home and abroad, and who would be competent to advise them as to when present or prospective rise or decline in prices justified them in asking for an increase of wages or submitting to a reduction. Most of their strikes to-day are due to their unwillingness to accept the assertions or opinions of the employer on this point. But we doubt whether a salaried officer of this kind would long retain this reputation for honesty, if really honest. Accusations of "selling out" to the employer and of being in sympathy with him would not be long in coming.—*The Nation.*

THE VICTORIA VIADUCT, CARLISLE, ENGLAND.

The new viaduct at Carlisle was declared open by the Princess Louise on the 20th of September last. It commences from English street, opposite Devonshire street, and is carried on a high level over the railway and river Caldew, terminating in Denton Holme.

The city of Carlisle, until recently a walled town, situated on a gentle eminence in the midst of the great Cumberland Plain, stretching from the mountains to Scotland and the Solway Frith, is almost entirely surrounded by three rivers, one of which, the river Caldew, flows from South to north, under the west walls of Carlisle, the only remaining portion of the ancient city walls, in a wide and open valley which divides the ancient city from the populous manufacturing suburb of Caldewgate, the descent on the city side being somewhat steep and precipitous. When about thirty years since the extension of the railway system from the south of England to cotland along the west side of the island took place, the railways were carried along the valley of the Caldew, between the river and the west walls of the city; access being given to the ground lying to the westward of the lines of railway by means of a street carried underneath the northern extremity of the Citadel Station. This street was subsequently, in the year 1852, extended to the river Caldew, and was carried over the river by means of a new bridge, completed in that year, and named the Nelson bridge, thus affording access to a large tract of land, now for the most part built over, and supplying an additional and important entrance to Carlisle from the west. As the railway traffic and the number of lines of railway making use of the Citadel Station increased, it became necessary to enlarge that station, and for this purpose the arch by which the lines of railway were carried over the street leading to the Nelson bridge was lengthened; the consequence being that the portion of street underneath was placed in a tunnel, and rendered darker and less convenient. In the year 1871, in consequence of the great increase of traffic, and the intended entrance of the Midland Railway Company into the Citadel Station, consequent on the opening of the new Carlisle & Settle Railway, the railway companies found it would be necessary to make extensive alterations in the Citadel Station, and the various lines of railway connected with it, and considerably to enlarge the station; and application was accordingly made to Parliament for powers for the purpose. The plans of the railway companies involved a considerable further lengthening of the arch carrying the lines of railway over the street leading to the Nelson Bridge. This was strongly objected to by the Corporation, and ultimately, in the Session of 1873, an arrangement was come to, with the sanction of Parliament, by which the Corporation were empowered, in the place of the street underneath the Station which was to be done away with, to carry a new line of street, by means of a viaduct on a high level, over the northern extremity of the Citadel Station, from the west side of English street to the Nelson Bridge, which, in order to admit of a line of railway passing underneath it, was to be pulled down and reconstructed at a much higher level. Towards the expense of this new street and viaduct the London and Northwestern and Caledonian Railway Companies were to contribute the sum of £38,000 besides executing various portions of the work more immediately connected with the lines of railway.

The viaduct and its several approaches are about 830 yards in length and 45 feet wide throughout. The roadway is paved with Dalbeattie granite, and the footways flagged with Lazonby stone. The parapets are made of red stone, and the copings of the white stone of the district. The English Damside and the railway are spanned by a wrought-iron viaduct in three openings. That over English Damside is 29 feet wide, with a clear height of 33 feet, and that over the railway is in two openings of the respective widths of 60 feet and 56 feet, and a clear height of 14 feet from the level of the rails, space being left between the two openings for a central roadway to the proposed island platform in the station. On the Bush Brow there are four brick arches, each with a span of 25 feet, and varying in height from 17 feet to 28 feet. There is also a wrought-iron bridge spanning Backhouse's Walk, the width of which is 15 feet, and height 12 feet. The roadway from this point to English street is supported by retaining walls. The river Caldew is spanned by three stone semicircular arches, 36 feet span, and 18 feet rise, and the loop-line to the westward is spanned by a wrought iron girder bridge, 40 feet wide and 14 feet high. The parapet of this and the other girder openings are panelled with bold and effective cast-iron trellis work. The Caldew Bridge is a well-designed, substantial and ornamental structure, the stonework being of tooled ashlar throughout. In addition to this there are two subways to the gas works, each spanned by wrought-iron girders. All the approaches to the viaduct are formed by retaining walls and solid embankments, the parapets and copings of which are neatly dressed and well-finished. The viaduct will be lighted by 26 ornamental circular gas lamps, four of which will have three lights. The approaches from Denton street and Charlotte street to the river Caldew have a gradient of 1 in 30, and over the river to the gas works is horizontal. The approaches from James street, Wood street, and the Caledonian Goods Yard have a gradient of 1 in 18. The viaduct from the gas works to the railway bridge has a gradient of one in 18. The roadway over the railway and English Damside is horizontal, and from the latter point it falls to English street at an inclination of 1 in 85. The plans for the viaduct were prepared by, and the works were commenced under the superintendence of Mr. Morley, late City Surveyor of Carlisle; since whose death they have been continued to completion under the superintendence of Mr. Hugh Unsworth McKie, the present city surveyor.—*The Architect.*

ARCHES;
CONSIDERED GRAPHICALLY.

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(*Continued from page 284.*)

94. In any practical case it will, probably, be more easy, and sufficiently accurate, to scale all these quantities from a good-sized diagram, but perhaps it will be well to calculate one set of values of M as an example. Let $\beta = 45^\circ$ and $\alpha = 20^\circ$. Then the arc β $=.7854$ and α $.3491$; sine $\beta = \cos\beta = .7071$; sine $\alpha = .3420$, $\cos\alpha = .9397$. The values, substituted in (26.), give

$$y_0 = r\,\frac{(.5-.1170)\,(.7854-\frac{2}{.7071}-2.1213)}{(.5-.1170)+1.4142\,(.1194+.9397-.5554-.7071)} = \frac{.0384}{.0954}\,r = .403\,r;$$

(27.) will then become

$$H = \frac{(.5-.1170)\,r}{1.4142\times.403\,r}\,W = \frac{.383}{.570}\,W = .672\,W$$

$\sin\beta + \sin\alpha = 1.0491$; $\sin\beta - \sin\alpha = .3651$.

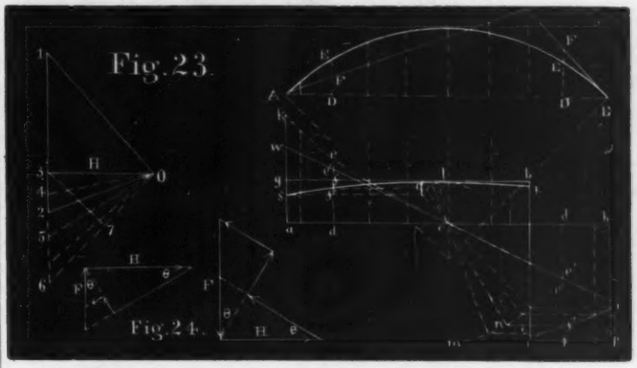
$$\frac{y_0}{\sin\beta+\sin\alpha} = \frac{.403\,r}{1.0491} = .384\,r; \qquad \frac{y_0}{\sin\beta-\sin\alpha} = \frac{.403\,r}{.3651} = 1.104\,r.$$

VALUES OF M.

θ		40°	30°	20°	10°	0°	10°	20°	30°	40°				
	sin β + sin θ	.7071 −.6428	−.5	−.3420	−.1736	0	+.1736	+.3420	.5	.7071 .6428	sin β − sin θ			
	mult. by .384	.0643 .384	.2071	.3651	.5335	.7071	.8807	1.0491	.2071	.0643 1.104	mult. by 1.104			
	− cos θ	.0247 .7660	.0795 .8660	.1402 .9397	.2049 .9848	.2715 1.0	.3382 .9848	.4029 .9397	.2286 .8660	.0710 .7660	− cos θ			
	+ cos β	−.7413 .7071	−.7865	−.7995	−.7799	−.7285	−.6466	−.5368	−.6374	−.6950 .7071	+ cos β			
	H	−.0342 .672	−.0794	−.0924	−.0728	−.0214	.0605	.1703	.0697	.0121 .672	r W	r W		
	M =	−.0230	−.0534	−.0621	−.0489	−.0144	.0407	.1144	.0468	.0081				

As just stated, all of these values of E F, as well as others which have preceded, can be found graphically, or verified, by drawing a diagram of moderate size. They may be seen in Fig. 23.

95. If we pursue the method hitherto employed for finding the shear on the web, we can no longer draw an inclined straight line through the middle point of *a b*, Fig. 23, and consider the ordinates to it as representing the amount of vertical force which must be combined with H to give a direct thrust at each section, leaving the remainder to be carried by the braces. As the arch is the arc of a circle it is not in equilibrium under a uniform load, as specified for the parabola, but the line which limits the ordinates for the amount of shear taken up by the flanges is convex to the horizontal line, and is represented by the dotted line *k e c p*. There is no difficulty in constructing this curve, for we have only to draw lines from o in the stress diagram parallel to the tangents, or perpendicular to the radii, at successive points of the rib, and plot the amount of load line, included between each one and the extremity, 3, of H, from *a b* vertically, below the point to which the tangent belongs. Thus 0-5 is parallel to the tangent at E and 3-5 is therefore laid off at *d e* below E. By repeating this operation for a number of points the curve *k e c* is located. If, then, *a g h i p b* is the shear diagram for a load at C, *a g* and *p b* being the two supporting forces, the amount of vertical force which must be carried by the web at any section, as E, will be represented by the ordinate *e f*.



96. While this construction will answer quite well for points in the rib where the tangent is not much inclined to the horizon, if we deal with an arch which subtends a large angle, at all approximating to two right angles, the tangents, as we approach the springing, making smaller angles with the vertical, will cut off longer distances from the load line, so that the curve *c e k* may recede to quite an inconvenient amount from *a*. Indeed, we see that, just at the springing point of a semi-circular arch, the tangent to the arch will be parallel to the load line of the stress diagram, and that, therefore, the ordinate to the curve of the vertical shear carried by the flanges will be infinite at this point, or the curve will have a vertical asymptote.

If 3-4, 3-2, 3-5, etc., are the amounts of shear to be laid off at the proper points of *a-b*, as just explained, they also represent the vertical components of the direct thrust, which is found in the flanges at the respective sections when this rib is the curve of equilibrium with the horizontal thrust H, and 3-4, 4-2, 2-5, etc., will represent the load required on the successive points of the rib to produce equilibrium. If, as in this figure, the *arch* is divided into equal portions, the angles made by the lines radiating from o will be equal, and, consequently, the successive portions 4-2, 2-5, etc., cut off from the load line, will be larger as we go from the crown to the springing, giving, therefore, for the load which will keep a circular rib in equilibrium, one whose amount per horizontal foot increases from the crown to each abutment, and becomes infinite at the springing of a semicircular arch. Hence it follows that no amount and distribution of vertical load can ever make a semicircular arch a true curve of equilibrium, that is one which has no bending moment at any point. In fact, no curve which starts vertically from the abutment can ever be a curve of equilibrium under vertical loads. This may be seen, in a more simple manner, if we consider that no arrangement of weights will cause a cord, attached to two points in the same horizontal line, to hang in a funicular polygon whose first side is vertical.

97. It has, consequently, been thought desirable to find the shear on a normal or right section of the rib, thus obtaining a diagram which will be comprised within moderate limits, a quantity which will be convenient for plotting or for calculation, since the two flanges are concentric, and one which can be readily resolved on bracing, usually so disposed as to make a constant angle with the normal or radius. If θ represents the angle which the tangent to the rib at any point makes with the horizontal, or that the radius to the same point makes with a vertical line, it will be evident that the normal component of the external forces at the section will be $F\cos\theta - H\sin\theta$, and that this component must all be carried by the bracing at that section, for the flange alone

cannot carry a normal force. In construc ting a shear diagram we can, after drawing $a\ g\ h\ i\ p\ b$ as usual, draw arcs of circles at l and m, with c as centre, and $a\ g$ and $b\ p$ as radii, lay off the angles θ from the vertical line $c\ l$ and $c\ m$, and project the points of the arcs so determined upon the proper verticals, thus constructing all the values of F cos θ. Thus we may draw $n\ c\ q$, parallel to the radius which passes through E and then project g horizontally to f'; $d\ f'$ will equal $d\ f$. cos θ. The point n may be, at the same time projected at f', for the similar point E on the right, in place of drawing another line through c parallel to the radius at this last point. By a few such constructions we rapidly locate the curves $s\ f'\ l\ t$ and $v\ r$. If we should determine the several values of H sin θ and lay them off from $a\ b$ on the same ordinates on which we have just placed the values of F cos θ, we should find that their extremities came in one straight line passing through c; for $c\ d =$ r sin θ, and an ordinate which is equal to H sin θ must vary directly as the distance from c. Therefore it is only necessary to determine the length of $a\ w$ or H sin β. This is readily done by drawing a right angled triangle 037 on 0-3 as an hypothenuse, 0-7 being parallel to a tangent at A and 3-7 parallel to the radius to the same point, when 0-3 = H, the angle 703 = θ, and therefore 3-7 = H sin θ, to be laid off at $a\ w$ and $b\ y$. Then if the straight line $w\ r$ is drawn, the shear on any right or normal section, and the resultant stress on the bracing at that section, will be the vertical ordinate between this line and the curve last drawn, such as $e'\ f'$ for the point E of the arch.

It is, however, so easy to compute the quantity F cos θ — H sin θ, that the labor of calculating a sufficient number of values is very trifling. We may then proceed to make a table, analogous to those which have gone before, for a weight on each point in succession, from which we can select that arrangement of loads which will give the maximum shear at any particular section.

98. We may also proceed in another manner, more especially if we have previously determined the amount and arrangement of loads which will give the maximum shear of either kind. Fig. 24 illustrates this device, being here constructed for the two points E of Fig. 23, with the load at C as there represented. The shear and thrust are taken on the left of any section and the forces in the pieces cut by the plane of section react against the plane from the right. Since the resultant forces at any section may be represented by F and H, lay off the total vertical shear F at the section, as obtained from the stress diagram 012, just as if we were dealing with a beam, and plot the value of H horizontally from that extremity which will allow the two arrows, showing the direction of action of these two forces on the left side of the section, to follow one another. Then draw lines from the free extremities of F and H parallel to the tangent to the rib at the particular point, such as E, Fig. 23. The perpendicular between these two lines will be the shear on the web at the normal section, as may be seen by noticing the angles marked θ in the figures. As in Fig. 19, the amount of stress in the two flanges is of no consequence here, when considering the bracing, as the perpendicular between two parallel lines will be unchanged in length wherever it may be drawn. As the two flanges are parallel, they are parallell to the tangent to the centre line at E. If they are not parallel, it is easily seen how the stress on the bracing or the shear on a normal section is altered, and we shall take advantage of this construction later. As the arrows on F and H denote the directions of their action on the left side of the section, the arrows on the other lines for the right side must pass in order round the remainder of the polygon to produce the required equilibrium. The direction of the action of the shear in the *web* on the *right* side of the sections E is therefore plainly indicated in these two figures, and hence we easily determine whether a particular piece of the bracing is a strut or tie, as explained in § 58, Fig. 12. It is noticeable, in the particular example of Figs. 23 and 24, that the normal shear on the web at E near the left abutment is the same kind with F, and near the right abutment is the opposite kind to F at that point, while it still acts upwards on the right of the normal section.

99. The horizontal thrust or tension due to a change of temperature in a circular rib which is hinged at the ends is found by a similar method to that pursued for the parabolic rib. Referring, to avoid repetition, to what was said at that time, §§ 77–82, equation (22.) may be written, as given in § 82,

$$H_t \cdot \Sigma D E^2 \pm = 2 E I \cdot t e c.$$

Fig. 18 will answer also for this case, if we imagine the arc to be circular. As we saw, in § 90, that $\Sigma D E^2$ for a semicircular arch was $\frac{\pi r^3}{2}$, a substitution in the above equation gives at once

$$H_t = \pm \frac{4 E I t e c}{\pi r^3} = \pm 1.264 \frac{E I t e}{r^3}. \qquad (29.)$$

The bending moment at the crown, where it is a maximum, will therefore be

$$M\ (\text{max.}) = \frac{4 E I t e}{\pi r^3}.$$

(To be continued.)

THE SOCIETY OF CIVIL ENGINEERS.

At the regular meeting of this society on the 3d inst. the result of a letter ballot upon several important resolutions was made known.

The first resolution provided for a committee to draft a law securing the inspection by experts "of all questionable bridges now in existence." It also provided for active exertions by the members of the society to promote the passage of such a law by the State legislatures.

The second resolution was similar, except that it related to tests of bridges before and at stated times after their opening for public travel.

The third resolution embodied a memorial, to be signed by the officers of the society and transmitted to Congress, in favor of the exclusive use in the government department and publications of the metric system.

The fourth resolution authorized the appointment of a committee to report upon what is the best system of weights and measures for the use of engineers in the United States.

The fifth and sixth resolutions established certain rules relative to the reading of papers and other order of business.

All these resolutions were lost by decisive majorities. So far as we can judge from the arguments for and against them, there were two considerations which influenced the members.

The first was the feeling that it is not the true policy of such a society to take official action with regard to proposed changes in practice or in legislation. The resolutions relating to the testing of bridges doubtless met, in spirit, if not perfectly in form, the approval of all. Yet the society, as the argument against the first resolution well expresses it, "is, *as a body*, not competent to set forth opinions on any special points of practice. It is not an association of bridge experts alone, nor is a majority of its members qualified to sit in judgment on the questions involved in bridge construction." Still less could they appear as experts upon questions of law.

The memorial to Congress in favor of the metric system was rejected, apparently because it was not satisfactory in form. The society, by letter ballot, had already voted that such a document should be prepared. Of course the opponents of the introduction of that system helped to vote it down. But even if the society were overwhelmingly in favor of such action by the Government, the policy of official action of this kind might well be questioned. For our own part, while we are heartily desirous of advancing in every way the inevitable adoption of the metric weights and measures in the United States, we do not think a society of engineers can properly go further, *as a body*, than to vote the adoption of that system in its own proceedings.

The resolutions relating to the reading of papers were defeated, as we infer, because it is better to let conventions manage their own affairs as far as possible; and because a needless multiplicity of rules in such societies is a nuisance.

It is significant that on all these questions only about 110 members voted at all. A majority of these would have been but a small fraction of the whole membership; and in view of this fact, the system of balloting by letter appears to be little better than that of a vote by the members present at an annual meeting. Indeed, considering how much better is the chance for bringing out the truth by argument in an open debate, and in the presence of the voters, we think that plan, on the whole, less likely to involve unwise decisions.

The two principles thus emphasized by the members of the Society of Civil Engineers have already been found most useful by the Institute of Mining Engineers. That body declines to vote at all on any question not directly involved in the management of its own special business—namely, the business of holding meetings, and reading, hearing, printing, and discussing professional papers. Moreover, the Institute has shown an almost invariable unwillingness to change its rules or to make new rules. Very excellent amendments have been proposed and defeated, simply because, in the absence of any pressing necessity, the Institute preferred to maintain its own liberty.

This is, in our judgment, undoubtedly the true system for the successful management of such associations. The constitution, backed by the steady spirit of the members, should rigidly restrict the objects of the society. The rules should be as few, as simple, and as permanent as possible. We congratulate our brethren of the Civil Engineers that these principles are recognized among them.

Nor do we regret that causes with which we are in sympathy should suffer apparent injury by the enforcement of these principles. It is just such cases that are needed to establish precedents. If the merits of every proposed reform in law, or in professional practice, were to be the ground of its official advocacy by a Society of Engineers, then nothing could well be rejected until its merits had been argued. Men ardently desirous of bringing about great improvements in society would be glad to use every agency that promised to be powerful; and the only way to check the attempts of well-meaning enthusiasts, without giving offense, is to decline to lend the influence of such a society to any public cause whatever. A definite purpose, no action outside of that purpose, and the utmost freedom and energy within its bounds—these are the conditions of success.—*Engineering and Mining Journal.*

The Commission appointed to examine the fire-proof qualities of the public buildings in Washington, have completed their report. They find that the new State Department building and coast survey are as near fire-proof as buildings can well be, which are filled with records. Two old wings of the Capitol adjoining the Congressional Library are very defective, and have much wood under the roofs. The War Department records

are stored in many buildings in great part mere tinder-boxes. The large Winder Building, in which are the engineers, ordnance, and army-rolls, is highly combustible in the upper part. The Treasury records are in a large degree exposed so far as the files of two of the important accounting divisions are concerned. Part of the Post-Office roof is supported on wooden rafters. The National Medical Museum, the finest collection in the world, in old Ford's Museum, is under a wooden roof and cornice. The Agricultural Department, with its museum, is also unsafe. In fact, nearly all the Government archives are in constant dang r from fire. The condition of affairs in this respect proves a surprise to everybody here, and presents questions which Congress must act upon at once. The remedy will require extended appropriations, and will furnish Congress much work.

From the *Engineering and Mining Journal* we take the following:

"The October meeting of the American Institute of Mining Engineers, will be held in Amenia, Dutchess County, N. Y., beginning Tuesday evening, October 23, at 8 o'clock.

Amenia is on the Harlem Railroad, and is reached by trains from New York, leaving at 10:30 A. M. and 3:50 P. M., arriving at 1:40 and 7:20 P. M. Members coming from the North, East, and West connect with the Harlem road at Chatham Four Corners on the Boston & Albany Railroad, where trains leave at 5:45 A. M. and 4 P. M., arriving at Amenia at 7:30 A. M and 5:30 P. M. There are ample hotel accommodations in Amenia.

In addition to the regular sessions for reading and discussion of papers, arrangements will be made to visit the ore beds in the vicinity of Amenia, the Salisbury Mines in Connecticut, and Richmond Mines in Massachusetts, also the car-wheel works of Messrs. Barnum, Richardson & Co., at Lime Rock, and the Copake Iron Works. It is also expected that an opportunity will be afforded to visit the Twin Lakes near Salisbury, and Bashbish Falls near Copake, and to ascend Mount Washington and Mount Everett.

It has been thought best to make Amenia the headquarters for the meeting instead of Poughkeepsie, as was intimated in the last issue of the *Journal*, owing to its more central position in the hematite ore district.

Local Committee.—JAMES F. LEWIS, Amenia, N. Y.
EASTON, Pa., Oct. 5, 1877. T. M. DROWN, Sec."

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Clinton Bridge Company, of Clinton, Iowa, have now under way in their shops, or in process of erection, 23 combination and 8 iron bridges, aggregating about 3,700 lineal feet. They have just contracted for 300,000 feet of bridge timber in Wisconsin, which they will need to finish up the contracts they now have on hand.

GAS AND WATER-WORKS.

The new water works offices in the City Hall, Cleveland, O., are being elegantly fitted up.

Ditching and grading are being rapidly prosecuted on the canal of the San Joaquin & Kings River Canal company, near Hill's Ferry, Stanislaus county, California.

It is likely that a report will be submitted to the Allegheny Pa. Council from the Engineer and Superintendent of the water works, relative to the leaks in the basin and the defects in the foundation under the pumps at the engine-house on the Allegheny river.

An Indiana exchange says: Some of the citizens of Peru are protesting against the council building water works for the city at a cost of $138,000. As an ample supply can be obtained for less than half that sum, it would seem that they have good cause for complaining.

The recent prevalence of typhoid fever in Rochester, N. Y., is proved by scientific analysis to be due to impure well water. Professor Lattimore, of Rochester University, has tested water from wells on forty different streets, and finds that surface drainage and bad sewers have made the average of impure salts per gallon 16.78 grains, an amount three or four times that which is compatible with health. He doubts if there is a well of pure water in the city.

The new buildings for the pumping works, on corner of Chestnut and Eighteenth streets, in the Second ward of Milwaukee Wis. are nicely progressing and there is no doubt but that they will be finished by the 15th day of December next, as the contract contemplates. They are built according to the plans designed by architict Gombert under the supervision of Chief Engineer Moses Lane, and when ready will add another ornament to those the city can boast of in shape of public buildings.

The Oakland, Cal. *Transcript* says:—H. S. Craven, civil engineer has assumed the office of chief engineer of the Mokelumne Ditch & Irrigation company. His preliminary report which has just been published embodies a vast amount of valuable statistical information. He pronounces the enterprise not only feasible, but one which must prove profitable to the stockholders. He recommends that a thorough survey be made of the entire line of the proposed canal, and particularly of that section between Bear Creek and the site of the dam, as many thousands of dollars can be saved by careful examination before making the permanent location. This work should be done as soon as possible, as excavation and embankment can be made at much less cost and of a more satisfactory character during the rainy season. Before an estimate can be made or contracts let the route must be cross-sectioned, and marked on the ground both the centre and side lines, and a careful plat made of the whole.

The Columbia, Ohio, water works, which are upon the Holly system, have now been in operation about seven years. Since they were built, the city has abandoned the use of their entire force of steam fire engines, and the losses by fire have been decreased from an average previous to the introduction of the water supply, of 65-100 of one per cent. to 9-100 of one per cent. upon the total tax valuation, while since 1870 the valuation of taxable property has increased, in round numbers, from $16,000,000 to $27,000,000 in 1876. The average daily amount of water now being pumped is about 1,600,000 gallons, the machinery with which the works are supplied being capable of furnishing 10,000,000 gallons daily for domestic use or 7,000,000 gallons under fire pressure. There are now in use in the city upwards of 600 improved water meters, from the Eagle Meter Co., of Brooklyn, L. I., which are recommended by the engineer in his report as giving better satisfaction than any meter yet tested. Since their introduction, three years ago, the consumption has but slightly increased, notwithstanding the growth of the city. There are about 45 miles of cast iron pipe laid, in connection with the works, which was furnished by H. R. Smith & Co., of Columbus, to the credit of which establishment it may be said that not a single length has thus far been obliged to be taken up from any faultiness of the pipe.

The city of Troy, N. Y., is agitated over the question of increased water supply and its probable source. Much opposition is manifested towards Hudson River on account of alleged impurity, but in reply to a note addressed to Water Commissioner Martin, of Albany, which city draws its additional supply from the Hudson, a very favorable report was received. The analysis made by Dr. C. F. Chandler, of New York, for the Albany authorities, proved the water to be remarkably pure, due as Mr. Martin suggests, to the large extent of water shed and the small population per square mile.

The result of the conference between the Committee appointed by the common council of the city of Louisville, Ky., and the directors of the Louisville Gas Company relative to a reduction in the price of gas to $2.25 per 1000 feet, is shown in the following letter from the gas company to the committee:

LOUISVILLE, KY., *October 11, 1877.*

I am directed by the Board of Directors of the Louisville Gas Company to inform you that it has carefully and fully weighed the statements made by you at the conference with which you honored us yesterday; that it has applied mature deliberation to the subject; that it is actuated by as strong a desire as yourselves to bring down the price of gas to the lowest figures compatible with a just consideration of the interests of the company it represents, and that the unanimous conclusion of the Board was that at present gas could not be furnished at a less rate than $2.35 per 1,000 feet. I am also authorized to say that it is the desire and intention of the Board, if it finds it possible to do so, to make a further reduction at a future time.

HENRY WHITSTONE, *President.*

The price given in the letter is "nett."

RAILROADS.

Thirty-five hundred men are at work on the extension of the Kansas Central road.

The first locomotive for Manitoba was shipped on a lighter at Fisher's Landing, Oct. 1.

The Worcester and Somerset R. R., Mass., eight miles long, was sold lately at Trustees sale for $4,600 to George A. Rahm, of Philadelphia.

A resolution was adopted by the city council of Cleveland, Ohio, authorizing the Cleveland, Columbus, Cincinnati and Indianapolis R. R. to lay a track in German street, according to an ordinance recently passed.

Work on the Sidney and Louisburg R. R., Nova Scotia, is progressing, and it is expected in three weeks the road from Lorway to Louisburg will be completed.

The contract has been let to Judge Garber, of Elkport, Iowa, for grading ten miles of the Turkey Valley R. R., from Elkport west. It is designed to have thirty miles of the road finished by winter.

The Santa Rosa, (Cal.) *Democrat* says: The most important thing now on the tapis for the rapid and permanent prospects of Santa Rosa is the building of the railroad from that city to Napa Junction.

The railroad from San Jose to Escuintala, Guatemala, is to be of the four feet eight and one-half inch gauge, so as to be in unison with the North American roads.

The Central Pacific R. R. Company purpose planting species of the *Eucalyptus* on both sides of their line through about 500 miles of the valleys of California. It is estimated that 800,000 trees will be required, and 40,000 have already been purchased.

The prospect for the extension of the railroad to the Commonwealth mine in Wisconsin, is every day growing brighter. If the deposit of ore is nearly as extensive as reported, and there is no reason to doubt its being so, the building of a railroad to it will be a question of short time only.

A very economically constructed railroad has just been completed in Middlesex county, Mass. It is also the narrowest in existence. The gauge is only two feet, the cars six feet wide, and the road eight and a half miles long. The engines weigh eleven tons each. The work cost $50,000.

The contractors of the Pittsburgh, Wheeling and Kentucky R. R. expect to have the ties and rails laid to Wellsburg in two weeks. They are now erecting trestle work, for a distance of about one hundred yards, at Cross Creek bridge. This will be the only trestle work along the line.

Interest is being revived in the construction of the Hardwick and Marshfield R. R. of Vermont. The proposed route for this road was surveyed in 1873, is 15 miles long, and connects the Portland and Ogdensburg R. R. at Hardwick with the Montpelier and Wells River R. R. at Marshfield. Responsible parties offer to furnish the means for completion, provided $50,000 can be raised along the line.

The people of Chagrin Falls, Ohio, have very promptly subscribed the necessary funds to finish their narrow gauge road to Solon; and if Messrs. Garfield, Warner, & Ferris, of Painesville, succeed in making a satisfactory arrangement with the company as is now expected, the work will be immediately commenced and completed at an early day.

A certificate of incorporation has been filed with the Secretary of State of Ohio, for the Shawnee, Hocking Valley and Southern R. R. Company, to run from a point at or near Shawnee on the Newark, Somerset and Straitsville R. R., passing through the counties of Perry, Hocking and Vinton, to a point at or near McArthur station on the Marietta and Cincinnati R. R.

A mass of rock weighing forty tons fell down the cliff upon the track of the Erie Railway at Carr's Rock, a few days ago, striking a freight train of forty-five cars.

The car struck was loaded with grain, and was completely wrecked. Twenty-two cars were behind it in the train. Of these, thirteen were thrown from the track.

At the meeting of the Directors of the Cleveland, Newton Falls, Salem and Salineville Narrow-Gauge R. R., of Ohio, held in Salem, last Thursday, considerable important business was accomplished. A preliminary survey will be made at once, commencing at Salineville, by Engineer Wilson, of Cleveland, aided by a competent corps of assistants. The prospects for building the road seem to be brightening with every step taken.

The railroad survey from Roseburg to the coast is progressing very rapidly; no very serious obstacles as yet. The route crosses the Umpqua river near that city, runs through Happy Looking Glass and Ten Mile valleys. Crosses the mountain in the pass of the Camas valley road, and from there follows the course of the Coquille to tide water. This road is of the utmost importance to southern Oregon and should be pushed to completion.

The *Mountaineer*, of Oregon, begs the O. S. N. Co. to build a road from Walla Walla valley to the Columbia river, so as to relieve the people from extortion. It says: We believe the O. S. N. Co. can bring the grain from Walla Walla to the river for two dollars per ton; for if they can carry it from Wallula to Portland—a distance of over two hundred miles, and handle it nine times—for six dollars per ton, they certainly can carry it thirty miles for two dollars per ton. Such a rate would save producers this year $100,000.

Mr. Chas. F. Mason, a prominent citizen of Glasgow, Kansas, has been employed to take the right of way over the line of the proposed railroad from Glasgow to Sturgeon. This new line has not been finally determined upon as the ronte over which the road will be run but the railroad company are attempting to arrive at the aggregate cost of running the road over this line, and also over the old line running by Fayette. The Sturgeon *Leader*, Oct. 2d, says the surveying party will reach that place from Higbee in the next ten days.

President Dillon, Jay Gould, Superintendent Clark, and other Union Pacific officials, made a complete tour of inspection over the road and its branches recently. The Longmont extension of the Colorado Central will be completed about Nov. 1, giving the Union Pacific connection with Denver over its own lines, and affording it access to the richest mining and agricultural regions of Colorado. Having recently secured control of the Utah Northern R. R., the Union Pacific will extend it northward, and endeavor to reach Fort Hall, Idaho, this winter, and eventually push the road into Montana. Work is to be begun very soon.

The Glendale and East River R. R. Company, L. I., whose line is a continuation of the Manhattan Beach R. R., applies to the Supreme Court for the appointment of commissioners to take land. This is opposed by Mr. Rowland, proprietor of the Continental Iron Works on West street, Greenpoint. He says that if the track is laid in front of his works he will have to remove his business to some other locality, as there will be no room for traffic on the street. Mr. Rowland has employed as many as twelve hundred workmen at one time, and now, when trade is dull, employs over five hundred. The matter was argued and submitted to Justice Pratt yesterday. For the railroad, Mr. Chapin; against it, Gen. P. S. Crooke.

The locating engineers of the Midland R. R. reached Mazeppa, Wabashaw Co., Minn. The contracts for grading are all let or bespoke for to the point just named. Gage & Downer expect to have 250 men at work at the end of the week. Ryan Bros. about the same. Other contractors are progressing favorably. The raft of bridge timbers for Campbell & Cook arrived safely last week and the bridging is progressing rapidly. It is expected that the next and final steps will follow without delay. The first installment of railroad iron—ten car loads—has arrived, and another train is daily expected. A train load of ties from the Duluth road are also on hand.

Rumors having spread, says the Philadelphia *Telegraph*, that the Pennsylvania railroad desired to rid itself of the United Lines of New Jersey, the stock of the latter fell, on Oct. 3d, from $128 to $122.50, but it recovered somewhat, reaching $124. It is stated in this connection that while the New Jersey leased lines have always proved a deep loss to the Pennsylvania Company, so far as earning a direct dividend is concerned, or even paying expenses, yet the company cannot get rid of the incubus. In addition to this the terminal facilities thus afforded, and the tapping of the New York trade, more than compensates the Pennsylvania Railroad Company for the loss sustained on the Jersey roads. Therefore the lease on these roads will not be cancelled, nor will efforts be made to have any changes in the terms of the contract.

The recent connection made by the Southern Pacific road by the bridge over the Colorado river was in direct opposition to orders from the government. Adjutant General Townsend, on August 2, gave the company permission to build a road across the government reservation at Fort Yuma, subject to a grant of right of way by Congress. The company thereupon proceeded to construct a bridge, but the Secretary of War, on Sept. 3, countermanded the permit until the controversy between the Texas and Southern Pacific companies was determined. The company obtained permission to continue work so far as necessary to preserve the bridge, but at midnight, Sept. 30, laid rails across, notwithstanding Major Dunn, from Fort Yuma, commanded the workmen to desist. Soon after a train crossed the bridge. It is believed the matter will be amicably arranged.

The Atchison, Topeka & Santa Fe Railroad, which is now running from Kansas City and Atchison to Pueblo, has just completed arrangements for the extension of its line to the Pacific Coast without asking any more assistance from the country than is usually granted to enterprises of such vast importance. This road is principally owned by Boston capitalists, who have already commenced the work of extending their line, and they have tendered the management of the road to a gentleman whose reputation is sufficient to guarantee a successful carrying out of the enterprise. Surveying parties are now in the field from Pueblo west, to lay out a line to connect with the Utah Southern, which will bring it to Salt Lake City and Ogden, where it will connect with the Central Pacific. The distance is less than 400 miles, and there are no particular obstacles in the way. This line will be superior in some respects to the Union Pacific, and has much less to suffer from rigorous winters. But besides this, it is contemplated to push the road southwest via Santa Fe, and connect it with the completed portion of the Southern Pacific, which is now running to Fort Yuma, and is being rapidly pushed eastward. The gentleman who, in all probability will take charge of the gigantic enterprise is Mr. W. B. Strong, General Superintendent of the Chicago, Burlington & Quincy Railroad. The position was offered to Mr. Strong several weeks ago with such inducements as to lead him to consider the offer favorably, and he has finally made up his mind to accept, provided the Directors of the Atchison, Topeka & Santa Fe will unanimously consent that he shall have full control without interference from any one.

The Missouri, Kansas & Texas Railroad makes the following statement of its gross earnings for the first week in October: Freight, $50,317.06; passengers, $18,294.20; mail, express, etc., $3,179.04; total, $71,790.30; corresponding period last year, $71,572.88. Mr. William J. Davis, Assistant General Passenger Agent of the Lake Shore & Michigan Southern Railroad returned from his California trip yesterday, in the best of health. The first locomotive, platform-cars, and rolling-stock of the Canada Pacific Railroad are now on their way to Winnepeg. The rolling stock is intended for construction service on the Pembina Branch of the Canadian Pacific Railway, and will be landed at Winnepeg in a day or two, and will doubtless be received by the populace at that place with great demonstrations. The earnings of the Grand Trunk Railway, of Canada, for the week ending Sept. 29, were $228,056, being an increase of $35,012 over the corresponding week of last year. The earnings the Grand Trunk for the four weeks in September this year were $97,185 greater than the same four weeks in 1876. A few shippers have threatened to test the legality of the trunk-line pool on the west-bound freight. Albert Fink, commissioner in charge of the pool, is reported as saying that if such suits are pressed, and result in judgments against the pool, the merchants will find themselves in a worse plight than before. In such case the trunk lines will cease to make out through bills of lading, and merchants will have to make connections themselves, necessitating the employment of commission merchants at Buffalo to handle goods, cart them to connecting roads, and make out other bills of lading.

MISCELLANEOUS.

The Hudson River is to be tunneled at the lower end of Manhattan Island.

Mr. Layard, the British Ambassador at Constantinople, has obtained a firman from the Sultan, allowing excavations in Nineveh.

The Pensioners of the late Civil War deprived of pensions from March 3, 1865, to June 6, 1866, have appointed a committee to enforce their claims upon Congress.

The Point Levi forts, Quebec, are at once to be put in a thorough and efficient state of repair by order of the Federal Government.

Among the ancient copper instruments collected for the State Historical Society of Wisconsin, by its Secretary, Prof. J. D. Butler, is a copper ax, weighing four pounds twelve and one-quarter ounces—the heaviest pre-historic object of copper hitherto discovered.

Orders have been given for the construction of several new steamships for the Cunard Line. The first of the series will be a steamship of 5,000 tons, for the Atlantic service. This vessel is to be called the Gallia. She will be the largest and most powerful steamship yet built for the Cunard service.

The Krupp Cannon Works in Germany are of immense dimensions. They send their armaments to all parts of the world, and employ an enormous capital. A striking feature of the establishment is a 100,000-pound trip-hammer. The Emperor William recently made a visit of inspection there, and 6,934 workmen turned out to receive him.

The mills at Passaic, N. J., were compelled to suspend operations lately by the stoppage of the turbine wheels. The hands were dismissed and the water drawn off when it was found that the wheels had become choked with eels. Over four bushels were taken out and the mill hands had eels enough to supply them with food for two days. The eels were washed into the mill-race by the freshet.

An immense cave has been discovered in Josephine county, Oregon. It has been found to be over five miles in extent, and the exploring is not yet completed. The stalactite formation overhead is said to be unique, being dissimilar to that in other caves of which more is known. A party will shortly make a thorough investigation of this mammoth cavern.

The Vice Consul General of the United States at Cairo has submitted to the State Department a statement showing the traffic through the Suez Canal for seven years past. The number of vessels carrying the British flag which passed through the canal during those years was 5,317, with a tonnage of 9,330,430, being more than twice the tonnage of all other nations. France is second, showing vessels to the number of 561, with a tonnage of 1,639,937. The number of vessels carrying the American flag was only 11, with a tonnage of 19,310. The number of vessels of all nations was 7,584, with a tonnage of 13,521,758.

A conference was held at Keokuk, Iowa, on Oct. 3d by the leading members of the St. Louis Chamber of Commerce and Major Stickney, engineer in charge of the Keokuk canal, to make arrangements, if possible to avoid closing the canal on account of the springing of the mitre sill of the lower lock. Commodore Davidson, President of the Keokuk Northern Line Packet Company wished to run his boats from above to the lower lock and transfer from there over the banks of the canal to the steamers in the river. In the evening Maj. Stickney decided to build a coffer dam above the upper gate of the lower lock of the canal to protect the gates and allow steamboats to transfer from the outer bank of the canal to boats in the river. Hence navigation will not be closed on the upper river, as expected. A force of men are at work on the coffer dam.

The engineer-in-chief of the Australian colony of Victoria has during the past two years made a tour of the world to examine the railway system of all countries. The result is given in an elaborate report. He is of the opinion that our ordinary passenger cars are decidedly inferior to English first-class carriages, especially in long journeys. "The want of support for the head and shoulders, the draughts and chills which from one window will sweep over fifty or sixty passengers, are all drawbacks to the American system. Again, the newsboys and hawkers passing up and down become an insufferable nuisance. On the other hand, there is no doubt but that the American cars do give great facilities for collecting and examining tickets, and consequently do save many delays."

The State Board of Public Works has just been making a tour of inspection of the Ohio canal from Cleveland to Portsmouth. On the first day, between Cleveland and Peninsula, twenty-two boats were passed. The second day, to Canal Fulton, thirty-five boats. Third day, to Canal Dover, ten boats. Thus sixty-seven boats were passed in three days, all loaded with coal for Cleveland, each boat averaging eighty tons, and drawing from three feet three inches to three feet ten inches of water. From Canal Dover to Circleville some five or six boats were passed, and from Circleville to Portsmouth not to exceed twenty. The locks, aqueducts, embankments, wiers, etc., were all carefully examined and found to be in good working order, nothing but ordinary repairs being required on them.

The New York *World* of Oct. 7 had a long article descriptive of the two Egyptian obelisks of rose-colored syenite, known as Cleopatra's Needles, which for nearly two thousand years have stood on the shores of the Levant, and announced an authorized statement to the effect that the Khedive of Egypt has signified his willingness to present to the city of New York one of these obelisks, the other having been accepted by England. The contractors who are now conveying the English obelisk to its destination are prepared to bring its companion to America and erect it on any site which may be selected for it at a cost not exceeding $100,000, the contractors assuming every risk. The obelisk offered to this country is seventy feet in length, and is the superior one of the two.

EAD'S JETTIES.

We are in receipt of the Seventh Report upon the Improvement of the South Pass of the Mississippi River, showing the condition of the works on July 24th 1877, by M. R. Brown, Capt. of Engineers, U. S. A. The report contains 30 pages of reading matter and 6 large lithographed charts of soundings and of numerous sections of the jetties showing work done and condition of bottom of river between the jetties and beyond the bar in the Gulf. These we are unable to give to our readers. The summing up of Capt. Brown's Report is given in the following communications to the New Orleans papers.

UNITED STATES ENGINEER OFFICE,
PORT EADS, SOUTH PASS, LA.,
June 29, 1877

On the 28th day of June, 1877, there was a practicable but narrow channel 60 feet in width and of 18 feet depth at average flood-tide through the bar at South Pass. At high water of the day 18½ feet was found. At low water of the day 17.2 feet.

At the date of my last survey at the head of passes, June 15, 23 feet at average flood-tide was found to be the least depth through the channel at the head of South Pass.

At the present stage of the river this depth is increased at the high water of a moderate tide to 24½ feet.

On the 30th day of June another survey of the bar at South Pass revealed the same depth in the channel as was found on the 28th.

On South Pass bar, for a vessel drawing 20 feet, the interruption of navigation is about 200 feet in length.

Above the South Pass bar, between the jetties, nearly throughout their whole length, a very great scour has been progressing for two months or more. More than 80 feet of water has been found at a late date in one place.

I certify that the above is a correct statement of the result of my latest partial surveys.

M. R. BROWN,
Captain Engineers, U. S. A.

Official. Furnished by order of the Honorable Secretary of War.

UNITED STATES ENGINEER OFFICE,
PORT EADS, SOUTH PASS, LA.,
July 28th, 1877.

On the 28th day of July there was a 20-foot channel at average flood-tide through the bar at South Pass, and entirely through the pass, and between the jetties. Its least width was 145 feet. A very narrow channel of 20.6 feet could be traced through. The interruption to navigation to a vessel drawing 22 feet was 145 feet in length. With the exception of one small lump, the 22-foot channel was 200 feet wide until a point was reached 1,270 feet from the present end of the east jetty. Until a position is reached 170 feet northerly from the end of the east jetty, the least width of the 22-foot channel was 120 feet.

I certify that the above is a correct statement taken from the results of my latest survey.

M. R. BROWN.
Captain Engineers U. S. A.

Official: Furnished by order of the honorable Secretary of War.

The following extracts from a letter of Captain Eads, embodying the results of Capt. Brown's surveys, are taken from a New Orleans paper.

The following extracts from an official letter dated Jan. 22, 1874, to the Hon. George W. McCrary, written by Gen. A. A. Humphreys, Chief of Engineers, U. S. A. and read in the House of Representatives when the Jetty bill was defeated, during the first session of the Forty-third Congress, illustrate some of the opinions that were held by the professional or technical opposers of the measure at that time:

The jetties cannot be extended indefinitely; the effect of their extension will be to reduce the volume of discharge of the jetty pass and divert its waters to the other passes. Under the terms of the bill you have sent me, if it is applied to the Southwest Pass, this extension of jetties would amount to six or seven miles in thirty years; whereas the advance of the bar in its natural state during that period would be about two miles.

The earthy matter pushed along the bottom of the river, will not be pushed out any farther by deepening the channel and accelerating the current by means of jetties than it was before; but instead of the bar of the Southwest Pass growing about 340 feet every year, it will, with jetties and with the depth of channel required in the bill, grow about 1,200 feet every year.

Against this charge Capt. Eads replies:

In view of the prophesied failure of the jetties, it seems curious that the most remarkable phenomenon developed by their construction, namely, the deepening of the sea-bottom in the precise locality where the new shoal was to form, should not only prove the absurdity of these predictions, but that it should likewise prove the existence of a littoral or shore current in the sea flowing almost constantly from the east, and passing transversely under the river discharge, by which the sea-bottom is deepened as the depth of the river volume is increased. The existence of this current was denied by the opposers of the jetties, and their predicted failure was deemed additionally certain because of its supposed absence. The non-existence of such a current could not, however, cause their failure, nor involve an extension of the jetties within the next half-century, in my opinion; but the existence of it must postpone the question of their prolongation far beyond the next Centennial.

About a year after the jetties were begun a survey that was made by my assistant engineers of the sea-bottom in an area of fifty-one acres immediately in advance of the jetties revealed the fact that, instead of the predicted reformation of the bar, there had been an actual average increase of nearly two and a half feet in depth throughout this area. About the time we had discovered this fact, Maj. Howell, United States Engineers, published a statement to the effect that an examination of the bar made by him showed that a new bar was forming immediately in advance of the jetties.

* * * * * * *

The statement made by the Superintendent in compliance with the resolution of the House was, in effect, that, in an area of 700 yards square (about 100 acres) immediately in front of the jetties, there had been an average scour between May, 1875, and May, 1876, of 68,400 cubic yards.

The comparative chart of the two surveys showed that the average depth of the 189 soundings made in this area, in 1875, was 33 and 9-10 feet, while the average of the 157 soundings made in it in 1876 was 35 and 6-10 feet, the average increase in depth being 1 and 7-10 feet. But such reference was made to the incompleteness of the last survey in the statement of the Superintendent that its testimony was much impaired and the public were left still in doubt on the question at issue.

A second survey, made by my assistants last May, showed that, in the fifty-one acres previously investigated by them, there had been an additional average increase of nearly two and a half feet from May, 1876, to May, 1877, making a total deepening of nearly five feet since the survey of Mr. Marinden in 1875. As the late United States Inspector, Gen. Comstock, had failed to report any deepening in front of the jetties, I complained of the fact by letter to the Honorable Secretary of War, and asked that the present Inspecter be directed to make a thorough survey of the Gulf bottom in front of the jetties and report the result. I immediately applied to the Superintendent for an official copy of the results of the survey, but they were refused for the reason that the survey was unauthorized by law, as the jetty act provided that such surveys should be made by the War Department.

The result of Capt. Brown's examinations will be found on pages 26 and 30 and on chart No. 4 of his report. A complete tabulated statement of the comparative results of his surveys is printed on page 30. The area investigated contains about one and a quarter square miles, and is subdivided on the chart into twenty-one parts. Seventeen of the twenty-one subdivisions, containing an area of about 540 acres, or eigthty-four hundredths of a square mile, are embraced between two lines radiating from the sea ends of the two jetties and extending seawardly to two points about one and a half miles apart, each of the two lines being about one and a quarter miles long. The fan-shaped area within these lines contains all, and more, than the area which is usually covered by the current of the river beyond the jetties, out to the limit of the survey.

Capt. Brown states that within this entire fan-shaped area there has been an average deepening during the year equal to one foot and three and seven-tenths inches.

Sections 1, 7 and 13 lie to the east and section 21 to the west of the fan-shaped area referred to, and are wholly outside of the river discharge.

The prevailing westerly sea current has a tendency to sweep the deposits brought down by the river to the west, and it is not probable that any shoaling, so far east of the jetties as section 1, has really occurred. By including and averaging this section with areas that have received from ten to twenty times as much investigation, the real value of Capt. Brown's careful work is liable to be underestimated. By throwing out this section no average fill, but a scour of eight-tenths of a foot is shown over the remaining twenty sections.

From the district on which the anticipated shoaling was to occur, there have been actually taken away from it under the effect of the jetties, in the twelve months, according to Capt. Brown's surveys, 1,145,976 cubic yards of deposit,—a quantity sufficient to fill a street or canal fifty feet wide and ten miles long to an average depth of eleven and a half feet, and this, too, occurred while the river current took up from the jetty channel an additional amount sufficient to fill to the same depth a canal twice as large.

The report shows that the amount of material removed from between the jetties in a period of 107 days was equal to 1,546,917 cubic yards. Surely if the reformation of the bar is to take place within the next century, it would show some signs of it during the period when the channel between the jetties is being washed out and formed. Already about 5,000,000 cubic yards have been removed from between them, and a very large additional amount has been removed by the effect of our works at the head of the pass, where a channel has been scoured out with a minimum depth through it of nearly, or quite, twenty-three feet, and yet we find a continual deepening of the sea immediately in advance of the discharge from the jetties.

Although the river has been extremely low for several months and its erosive forces greatly reduced, the solidification of the jetties by sedimentary deposit in them and by the compressing effects of the large quantity of stone put on them, has tendered to give us more benefit from the river current and from tidal action than we could otherwise have had, so that a continual improvement in the channel has been noticeable ever since the low water season began.

The improvement of the channel has been such that the government has ceased its dredging operations at Southwest Pass, and the jetty channel is now the recognized highway for the deep-draft vessels trading to New Orleans. Capt. Brown, in his August report, gives twenty feet and six-tenths as the least depth of channel through the jetties. Recent advices give a wide channel over twenty-one feet deep. JAMES B. EADS.

We are also in receipt of a chart of soundings on South Pass Bar, of date Oct. 3, 1877, and judging from that exhibit, the Engineers of the jetties feel confident of having a full 22 feet by 200 feet channel clear to the gulf before the present writing.

The problem at the South Pass is daily becoming of more interest to the people who have to pay the bill, and Engineers who have paid any attention to the subject are no doubt watching the proceedings of Capt. Eads and his Engineers with constant interest.

We have in this Journal endeavored to keep our readers posted on the progress of the jetties, and have commented pretty freely about them. At present we can only do as the rest of our brethren are doing; hope on quietly and watch the contest between Eads and the great river and the jetty opponents.

TAUNTON, MASS., WATER WORKS.

The New Bedford, Mass., *Mercury* says: "The Superior Court at Taunton has been occupied for the past week in the trial of three cases growing out of the establishment of the Taunton Water Works, and some interesting features in hydraulics have been under discussion. These works are upon the Holly system, and consist of a filter basin about 400 feet long, located by the side of Taunton river. From the basin, which is several feet below the bottom of the river, and into which water filters, the engines pump directly into the pipes, without any reservoirs whatever. The land slopes gently upward from the basin for about 300 yards, and the petitioners claimed that the water came from the land and not from the river. Upon the question many scientific gentlemen testified, including Professor Hayes of Boston, Mr. Herschel of Boston, Civil Engineer, for the petitioners; and Prof. Nichols of the Technological Institute, Mr. Rotch of Fall River and Mr. Martine, Civil Engineer, for the city. Some thirty witnesses have been examined, and elaborate experiments by tubular wells and otherwise have been made to ascertain the real truth. The jury were charged, Tuesday morning, by Judge Brigham, and a verdict was rendered for the plaintiffs in all their cases."

In reply to our enquiries in this case the following from Mr. Clemens Herschel is received:

BOSTON, *October 22, 1877.*

EDITOR ENGINEERING NEWS:

Dear Sir.—I have your card of the 18th. The case at Taunton was a suit brought for estimation of damages by taking of land upon which city of Taunton built pumping station and so-called "filter-basin" for a public water supply. From an engineering point of view the questions involved were these: Plaintiffs claimed that the water pumped by the city was spring-water, that the so-called "filter basin" which pretended to filter river water, was in effect nothing but a large well; in plan an oblong rectangle, instead of round as usual in wells, in vertical section with side slopes of 1½ on 1, instead of perpendicular, as wells are usually constructed. They endeavored to prove this claim by the usual proofs offered in such cases, many of which have been tried in Massachusetts, of temperature, relative heights, and chemical and other tests and analysis of the waters. And then claimed that this undue drafting of water out of this one spot, did already, and would still further, as the draft increased unduly lower the level of the water in the ground for distances of ¼ mile and more round about; and did and would thus work injury to plaintiffs estate, by lowering the water in their wells, by draining the soil too much, and by injury to a wood-lot now growing on a reclaimed swamp, a species of soil especially liable to injury from over-drainage, which had already shrunk so much from this cause as to leave the roots of the trees entirely out of the ground for various lengths about the trees. Defendants contended on the other hand, that they took the water for the city supply from the river and filtered it through a bank of gravel lying between the basin and the river, and hence worked no injury to

plaintiffs land, and none to plaintiffs, beyond the taking of so many acres of farm land.

Other points involved were not of an engineering nature. The case was before a jury, and I have not yet heard their award. Yours truly,

CLEMENS HERSCHEL.

LIGHTING RAILROAD CARS WITH GAS.

In answer to the inquirers of the *Car Builder* we would say, that the railroad company referred to in ENGINEERING NEWS of Sept. 15th that substituted petroleum gas for coal gas, with such marked success, is the well known Philadelphia and Reading. Its petroleum gas works were built in 1874 under the personal supervision of the inventor, J. D. Patton, of Hicksville Ohio, and were put in operation on Sept. 29th of that year, since which time they have been used for lighting not only the passenger cars but all the extensive shops, depot, and offices of that company at Reading Pa.; and although their construction was elaborate, and much more expensive than it would now be, the records of the company show that in a little over two years they have saved a sum equal to their entire cost.

At present prices of material and labor and with the economies of construction recently introduced by Mr. Patton, a gas works on similar plans would repay its cost within a single year, to any one of our large railroads.

Beside this the process is so simple, and easy to construct and manage that it can be advantageously employed for the lighting of single depots of the larger class.

The means of using this gas on passenger cars are the same as those used by the Pennsylvania railroad for coal gas, with this very great advantage in favor of the new light *i. e.* that the supply in a cylinder filled with oil gas will last five times as long as the same quantity of coal gas when giving the same light, thereby enabling a car to carry without inconvenience a supply sufficient for several nights use just as readily as it could carry a single nights supply of coal gas.

The superiority of this light to either coal gas or oil lamps is most marked, and we think that the press of this country will be forwarding a great public benefit in urging its adoption by our leading railways.

It may not be out of place to say that the adoption of the absurd rubber bag plan has been urged by the organs of the gas manufacturers in this country and England, as a matter of policy because it is designed in details, to enable the gas companies to supply the gas required for lighting passenger cars, from their ordinary mains, whereas the Patton method enables the railway companies to manufacture their own gas for both cars and shops, and thus deprives the gas companies of an extensive and very profitable line of customers.

Both the Pennsylvania and the Philadelphia & Reading railroads compress the gas into receivers at high pressure before using it, and this pressure has been found very injurious to coal gas, and very little injurious to oil gas. This pressure is necessary in order to carry a large quantity of gas in a small space.

The use of rubber bags for this purpose was tried by the Pennsylvania railroad company many years ago and abandoned as impracticable.

THE most important item of railroad news for the week is the sale by the stockholders of the Empire Transportation Co., of their entire property to the Pennsylvania Railroad Company, for the sum of $4,600,000, of which $2,500,000 is cash, and balance in bonds secured upon the property of the selling company. The total consideration will amount to fully $5,000 000. This transfer gives the Pennsylvania Company complete control of the oil trade of Pennsylvania, the extent of which may be conjectured when it is known that the total net freight collected last year amounted to $2,577,265. The Empire Company give as a reason for selling that it is imperative upon it to engage only in the purchase and sale of oil. The Company has been in operation twelve years, and the stock is owned mostly by parties connected with the Pennsylvania R. R. Co.

BESSEMER STEEL WORKS.

From a very interesting paper on "The American Iron Master's Work" contributed to the *Atlantic Monthly* for November, by Rossiter W. Raymond of the *Engineering and Mining Journal*, we make the following extracts. The entire article should be read by every person interested in the iron trade of this country:

"The Bessemer process (of making steel) is one of the most picturesque and striking in metallurgy. When first invented, it was recommended as a substitute for other processes (puddling, etc.) which involved much manual labor; and its great capabilities of improvement in respect of mechanical economy have fairly taken the world by surprise. The interior of a large Bessemer establishment like that at Bethlehem, Pennsylvania, is as impressive as a cathedral. The two great converters (or "pears," as the Germans call them, in allusion to their shape) are mounted side by side on a platform above the general floor. They swing on trunnions, so that they can turn their mouths upwards to receive a charge, or downwards to discharge it. The cupola furnaces for the preliminary melting of pig-iron and spiegel are usually behind the converters and on a still higher level, so that, when tapped, the molten metal may flow through a runner into the mouth of the converter. (This is not the case at Bethlehem, where the melted pig is brought in a huge pot and lifted to the converter.) All the heavy operations are conducted by hydraulic power. Let us ascend, at one side of the great hall, the platform or pulpit where a couple of men stand behind a row of levers, controlling by a touch the movements of the ponderous converters and of huge cranes here and there. The pumping-engines and blowing-engines are out of sight, in another room. This hiding of the causes gives to the effects an appearance of magic."

"A "blow" or "heat" is about to commence. One of the converters turns slowly on its axis, until its mouth is on a level with the platform. Immediately a fiery stream of molten iron appears from the obscurity of the recess behind, in which stand the cupola furnaces, and flows rapidly through a movable gutter into the mouth of the vessel. A workman at one side touches a lever, and the converter, which has lain, as it were, on its side to drink in its glowing charge, swings into a vertical position, with its mouth directed towards the throat of a large chimney behind and over it. An instant before however, a touch upon another lever has caused the monster to begin to roar and to belch a yellowish flame. This is the effect of the combustion of silicon by the blast which is delivered under a pressure of fifteen to twenty pounds per square inch, through the hollow axis of the vessel, down its side in an exterior pipe, and finally through its perforated bottom into the mass of fluid iron. After five or six minutes, the flame grows white and intolerably brilliant. The carbon is burning, and with so much intense ebullition that particles of melted iron and finely-divided slag are thrown out in showers of sparks. Six minutes more, and a quieter flame, with bluish tinge and still greater heat, indicates the last stage of conversion. Suddenly the flame shortens with a jerk, as if the monster had drawn in his fiery tongue. With an almost human air of exhaustion after its fit of fury, the converter rolls back upon its belly, to drink, by way of cordial, its final dose of spiegel. This produces a brief internal commotion, but it is soon digested, and the heat is over. Nothing remains but to pour five tons of liquid steel in a dazzling, almost transparent, incomparably beautiful stream, into the ladle which delivers it in turn to the ingot-molds. A Bessemer blow is perhaps the most imposing spectacle which metallurgical industry can present. The apparently automatic movements of great masses, the overwhelming display of vehement chemical reactions, and of light and heat in consequence, and finally the rapidity of the whole process, which can be seen from beginning to end in twenty minutes, combine to render it unique as a "sensational" exhibition. The sudden shortening of the flame at the end of the carbon reaction is so decided that the precise moment of its occurrence may be distinguished from a distance of miles."

"There are eleven Bessemer works in the United States, one of which went into operation in 1876, and two in 1875. The product of Bessemer metal in 1875 was 259,700 tons. The product of open-earth steel in the same year was 8,080 tons only. But this may be expected to increase rapidly after the present depression of business shall have passed away."

"One of these large establishments is a world in itself. There are the near or distant mines and quarries supplying the raw material; the railroads and canals, which bring a steady stream of supplies and carry away a steady stream of manufactured products; the blast-furnaces, which must not stop, day or night; the mighty blowing-engines, the pumps, the pipes, the ovens, all of which must be vigilantly guarded against accidents, which would bring certainly great loss and possibly great disaster, the army of workmen engaged in making or moving materials and products, or in perpetual constructions and repairs; the repair shops, each with its system of machines and necessity of thorough administration. To this must be added the chemical department, whether represented by a regular laboratory and a chemist, or by occasional employment of scientific assistance. The quality of ores and mixtures and of the products must be ascertained and controlled; the furnaces must be managed, humored, corrected, nursed, like so many willful or ailing children. The workmen and their families are usually tenants as well; and the management, perhaps, complicates matters still further by keeping a store. Finally comes the crowning feat (in these times, at least) of selling the iron, shipping it, and getting paid for it in due time. All this multifarious dealing with human nature, physical laws, and commercial conditions is required for the mere administration of a large establishment manufacturing pig-iron only. But add to that (as in many instances the case) Bessemer works, Martin steel works, rolling mills, wire mills, nail mills, plate mills, etc., all under one management, and each having its internal economy which must be harmonized with all the rest, and the conception of the powers of the human mind in organizing and directing industry is greatly enlarged.

It is true that in this, and in many other departments, the final impressive aggregate is the result of growth. Many establishments began small and have gradually increased to their present size. But what shall we say of works like the Edgar Thompson at Pittsburgh, or those at Joliet or North Chicago, which sprang from the brain of the designing engineer, complete in the beauty of symmetry and adaptation! For our part, we must declare our conviction that the original production of such plans, in whole and in detail, by the engineer seems to us an intellectual act partaking of inspiration. The architect of a cathedral, the author of a great poem, do not more distinctly create than do the quiet gentlemen who thus shape in advance the forms and the future of a mighty industry.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

An adjourned *regular* and *stated* meeting for transaction of business and consideration of professional topics, was held Thursday, Oct. 18th, at eight o'clock P. M.

The Twenty-fifth Annual Meeting of the Society will be held Wednesday, November 7th, at ten o'clock, A. M. The annual report of the board of Direction, on the affairs of the society, including the report of the treasurer, will be presented; officers for the ensuing year elected; the Norman Medal awarded; time and place of the Tenth Annual Convention fixed; ballots for members canvassed; action taken upon pending amendments to the constitution, relating to the proposal, election, classification, remission of dues, prohibition from voting and expulsion of members, and to the by-laws relating to adoption of future amendments; also upon resolution defining duties of the Secretary; and other important business done.

Reports from committees, as follows, will be called for:

Centennial Commission of the Society, Theodore G. Ellis, Chairman.

Gauging of streams, and nomenclature and classification of Masonry, J. James R Croes, Chairman.

Metric system of weights and measures, Clemens Herschel, Chairman.

Permanent quarters of the Society, John Bogart, Chairman.

Resistance of railway trains, and uniform accounts and returns of railroad companies, Willlam P. Shinn, Chairman.

Tests of American iron and steel, W. Sooy Smith, Chairman.

An informal dinner for members of the Society and invited guests will be held in the evening.

A circular has been sent to members, embodying this announcement, asking each to say whether he will be present at the Annual Meeting, and if he will join in the dinner proposed; also to state his preference as to time and place of the next, the Tenth—Annual Convention. Members are requested to promptly forward replies to the Secretary.

Papers have been presented since last announcement, as follows: Levees; a discussion. J. Foster Flagg, Aug. 25, 187-. Connected Arc Marine Boilers; a discussion. J. Foster Flagg, Aug. 31, 1877.

Papers on engineering subjects, giving results of practice, or in discussion of pertinent theoretical questions, are desired from members of the Society; their comments (whether or not present at meetings of the

Society) upon papers published in transactions are solicited, and they are urged to contribute from note-books and other similar records whatever may bear upon the subjects considered, or refer to other practical topics. A list of the subjects relating to the practice of engineering and its connection with kindred art and public affairs, on which papers are desired, may be found on page 51, vol. 1, of the "Transactions of the American Society of Civil Engineers."

Attention is called to the following resolution, adopted at the Ninth Annual Convention:

Whereas, the metric system of weights and measures is now extensively used abroad; and whereas, it is desirable that the relation of the units of differing systems be made familiar to all, by comparison:

Resolved, that members be requested, in papers hereafter presented to the Society, to write in parenthesis, weights or dimensions by the metric system in connection with those of the system in general use.

ADDITIONS AND CHANGES.

Additions. James B. Atkinson, Sec. and Treas. St. Bernard Coal Co., Earlington, Ky, Sept. 5, 1877; Charles B. Brush, (associate to member), Spielman & Brush, Hoboken, N. J., Sept. 5, 1877; William D. Bullock, Ass't. Engineer Water Works, Providence, R. I., Sept. 5, 1877; Philip Golay, Chief Engineer Miami Valley Railway, Cincinnati, Ohio, Sept. 5, 1877; James A. Hayward, drawer 432, New Orleans, La., Sept. 5, 1877, William B. Hyde, Oakland, Cal., July 12, 1877; H. W. Parkhurst, Louisiana, Mo., Sept. 5, 1877; Arthur Spielman, (associate to member), Spielman & Brush, Hoboken, N. J., Sept. 5, 1877.

Changes and Corrections. Hezekiah Bissell, (care American Society Civil Engineers), New York; Lefferts L. Buck, (care W. G. Swan) Suspension Bridge, N. Y.; George D. Emerson, 31 Washington place, New York; John M. Goodwin, Eng. Sharpsville R. R., Sharpsville, Mercer county, Pa.; John Houston, Spring Valley, Rockland Co., N. Y.; William B. Knight, Fordham Branch, Post Office New York; John McGee, (Care O. C. James), Rio Janeiro, Brazil; Niles Meriwether, Huntsville, Ala.; Robert Moore, Sewer Commissioner, St. Louis, Mo.; Thomas S. Sedgwick, Chicago, Ill.

Resignations George D. Cabot, Lawrence, Mass., Oct. 4, 1877; Nils Mitander, New York, Oct. 3 1877.

Deaths. E. W. [F.] Ensign, (late of) Buffalo, N. Y., Oct. 1, 1877; Henry Tyson, (late of) Baltimore, Md., Sept. 2, 1877.

ON TUNNEL CONSTRUCTION*

BY ARTHUR ERNEST BALDWIN, A. K. C.,
Stud. Inst. C. E.

(*Concluded from page 289.*)

A description will now be given of some of the broken work, especially that at No. 3 shaft.

TABLE OF COMPRESSIVE STRENGTH OF VARIOUS BRICK EMBANKMENTS MADE AT SYDENHAM.

The results are the mean of six or seven series of experiments.

DESCRIPTION.	Crushing Load in tons.	Crushing load per square inch in tons.
Slop bricks (Sydenham).....	22	0.55
London stocks.....	23	0.57
Staffordshire blue bricks.....	35	0.87
Wet machine bricks (Sydenham)..	37	0.92
Dry machine B .& C. (Sydenham)..	40	1.00

The clay, as a rule, did not show any tendency to move for some time after the excavation had taken place, contact with the air for a certain time seeming to be necessary before it commenced to swell. When this swelling began sooner than usual the strength of the timbering had to be increased, sometimes to the extent of close-b rring the crown. Occasionally the bars would drop more than the 1 foot 6 inches or 2 feet allowed for them, and had to be raised before the arch could be got in. But the clay never seemed to exert its maximum pressure until after the brickwork was built. This may be explained as follows:—First, the lengths did not stand long enough on the timbers to give time for the clay to swell; and secondly, the brickwork being more rigid than the timber, would resist to a certain point and then give way entirely. As a rule the brickwork did not give way until a week after it was built. If it stood sound for a month, all danger was considered to be over. Although the quantity of broken work was so large, no length actually collapsed which was probably to some extent due to the precautions taken to prevent such a catastrophe, by the insertion of timber supports etc. As a rule, after the work had been crushed in a foot or so the pressure was exhausted, and no further movement was noticed even when the work was cut out and rebuilt. This crushing in of the work appeared inevitable, and was at length accepted as a necessary evil. For instance, after the adoption of the nearly circular section, it was made a rule to set the leading frames 1½ inches too wide at each side to allow for the walls bulging, which generally happened, and the brickwork seemed to submit to this amount of compression without any ill result. The allowance was made for the walls coming in before the arch was built; besides this the section was made 6 inches wider than the required width of the tunnel in order to allow for its coming in after the arch was built. A proof of the great intensity of the pressure was the frequent occurence of "backs," or sliding faces in the clay. These faces were highly polished—in fact, as the miners said, "you could see yourself in them;" and they often showed a "throw" of several inches (of recent origin), which, considering the depth below the surface, is remarkable. Sometimes the result of the pressure would only be to crush off large flakes of brickwork from the inner rings, and in such cases the inner ring only would be cut out and that in patches. Usually two or three rings would have to be removed; and in the worst cases the whole work had to be cut out to the back and rebuilt.

The expense and difficulties connected with broken work are very great. Not only has the work to be reinstated, but while these operations are going on all operations forward are stopped for want of space to convey away spoil, and the working face has to be secured with extra timbering.

The following concise description of progress at No. 3 shaft, compiled from records kept of the work done, gives an account of the worst case of broken work occurring in the tunnel. From the time of sinking the shaft to the completion of the tunnel the work was carried on at No. 3 continuously, without a break. The brickwork of the tunnel (No. 3) was commenced on the 11th of June, 1861, and the work continued to progress until about the end of August following, by which time the lengths had come in so much that the cutting out of broken work was commenced, the mining at both faces being stopped. The progress to this date had been only 68 feet from face to face, and at this point it remained till the middle of November, when a start was once more made. In the intervening ten weeks 500 cubic yards of brickwork had been cut out and rebuilt. The work was recommenced with a ten-ring arch and walls and an eight-ring invert. By the end of November two more lengths were got in, making in all 90 feet from face to face, when the second failure of the old repaired lengths again stopped the faces. This second failure was much more extensive than the first, the consequence being that the tunnel was not in working order again until the middle of March, 1862. During this time 350 cubic yards more brickwork were cut out, and 260 yards rebuilt; but no attempt was made to repair the shaft and side lengths, which were the worst crushed, a casing of brickwork 30 feet long being built to keep them from further collapse until such time as the pressure had expended itself. The wooden shaft was also partially lined with brickwork (lining and shaft 400 cubic yards). In the lengths beyond the casing every effort was made to secure the work, double ribs being put to the centres (which were kept in), and the laggings were extended to the invert and held up by stretching beams of 14-in by 14-in timber, and finally the whole system of centres, sills props, and stretchers was braced and strengthened in every direction; but there was no resisting the pressure. The centre ribs were twisted both vertically and horizontally, scarfed joints were pressed nearly square, and the stretching beams were forced 6 inches or 7 inches into the shaped pieces, and "bushed" out to nearly twice their normal size at the centre. Other stretchers, 5 feet apart placed between the tow-paths, were similarly acted upon. The invert, rose about 2 feet, and the side walls came in. The above took place in work which had already been once cut out and rebuilt in Staffordshire blue bricks ten rings thick. On March 12th, 1862, the miners once more commenced forward operations, and by the 17th of April the tunnel had been advanced 36 feet at the two faces. Having thus obtained a good start in better ground, the work of reconstruction was recommenced, and two lengths which had been standing on centres and props while the forward lengths were constructed, were taken down and made good, 369 cubic yards being cut out and 319 rebuilt. The advantage of leaving the rebuilding of these broken lengths until the lengths beyond them were completed is obvious, since they became "junction" lengths with sound work on either side. It was found necessary at this time to line the shaft throughout with brickwork, as it showed signs of collapsing, having twisted considerably. The amount of brickwork for relining the shaft was 221 cubic yards. The brick sumping, too, was curiously distorted, and was repaired. On the 14th of June, 1863, the 30 feet casing being still in, but the work (at last) otherwise in good order, the miners went forward once again, and the tunnel was recommenced to the section. A year had now elapsed, and the whole length of tunnel completed in that time was rather less than 125 feet at the two faces, and 30 feet of this had to be kept up by an inner casing. The prospect was not encouraging, but the worst ground was passed, and the new section was well suited to the work, so that from this time until the junctions were made, in April 1863, the work progressed slowly and steadily without further interruption. By this time the whole tunnel was complete, and one of the last works done was to cut out the casing and to cut out and rebuild a length of about 90 lineal feet of side walls and arch near No. 3 shaft. The total amount of broken work cut out in this short distance of 125 feet amounted to 1,800 cubic yards, and the work rebuilt to 1,717 cubic yards exclusive of shaft lining and casing. Here the average thickness of the permanent work was ten rings. Altogether this No. 3 shaft of the Sydenham tunnel was a most interesting and peculiar case of successful tunnelling. The foregoing describes the broken work at one shaft; but the history of the other six shafts is somewhat similar. For instance, at No. 5 shaft a section of the tunnel nearly 200 feet long, gave way, and two rings were cut out and replaced with blue bricks. A peculiarity of this case was that the pressure seemed to be acting sideways, the south-western wall bulging about 1 foot, and the north-eastern wall only 4 inches. At No. 6 shaft, although the depth was great in comparison, similar difficulties were encountered to those at No. 3, until the new section was adopted, and similar means were taken to rebuild the broken lengths. The cutting-out was done in 6-feet lengths. The new section being flat-topped admitted of the crown bricks of the old sections being left in; and the "horse head" was erected to form a support for the forward ends of the small "cutting out" bars, which held up the old crown, their other ends resting on the last restored length. The centres were inserted between the "horse-head" and the completed work.

The prices given in this Paper are generally the net cost of labor. The details of the rate of progress are confined to those portions of the tunnel which were built to the new section in eight-ring work. The portions of the tunnel built to the other sections and containing broken work varied so greatly in rate of progress and cost that any detailed information with respect to them would be valueless. The total cost of the tunnel, labor and materials, and incidentals, for similar reasons, would be useless if given in detail; and besides this, the items of plant, supervision, cost of bricks, etc., for tunnel, are so mixed up with other parts of the Sydenham section, London, Chatham, and Dover railway, that it is impossible to allot the right percentage to each. The general rate of progress, taking the average length as 12 feet 6 inches, and after the broken work was passed and everything in working order, was 10 lineal yards per face per month, which for seven shafts and fourteen faces gives 140 lineal yards per month for the whole tunnel. The miners worked in twelve-hour shifts, and it was usual for them to commence driving the working heading before the bricklayers were out, because only two miners could work in it, and it was advisable to get it out of hand, so that the whole force of miners could get to work as soon as possible after the bricklayers had gone out. The time

*From Proceedings of the Institution of Civil Engineers, London.

taken per length for mining and bricklaying was, from a variety of causes, very variable, but the following was the average: Mining and timbering, seven to ten days; brickwork (including centre-setting), three to four days.

The whole of the labour was underlet to sub-contractors, the prices paid being as follows:—

	£. s. d.	
Mining eight-ring work	12 16 6	per lineal yard.
" nine- "	13 3 0	" "
Brickwork in cement	0 5 6	per cubic yard.
" in lime	0 5 3	" "

This, taking eight-ring work to the new section, which gives 28.4 cubic yards per yard forward, makes the lime brickwork £7 9s. per lineal yard; and the total labor, mining and brickwork, £20 5s. 6d. per lineal yard. For this the sub-contractors had to find tools and candles, do all mining, timbering and brickwork, get bricks from the top of the shaft, run the excavation out on the bank, find horses, ponies, etc., and, in fact, execute all the labor except centre-setting; and as they had the same price for shaft and side lengths the prices could not have been excessive. The bricklayers generally took six shifts, or three days, per length, and the centre-setting took about one shift and cost 37s. per length, or 9s. per lineal yard of tunnel. The average cost of candles, including those used by the centre-setters, was 10s. per lineal yard.

The following is the detailed cost for labor in mining an average length:—

Time made in a 12 feet 6 inches Length of the Section in Eight Rings.

			s. d.	£. s. d.
Gangers,	11 days,	mining	at 7 0=	3 17 0
Miners,	45 "	"	" 6 0=	13 10 0
Laborers,	34 "	"	" 4 0=	6 16 0
Banksmen,	10 "	at shaft	" 4 0=	2 0 0
Fillers,	38 "	filling skips	" 3 6=	6 13 0
Laborers,	27 "	running out	" 3 3=	4 7 9
Boys,	10 "	sundry work	" 2 0=	1 0 0
Horses,	10 "	at gin	" 7 0=	3 10 0
Ponies,	7 "	drawing skips	" 5 0=	1 15 0
				£43 8 9

Equals £10 8 6 Per lineal yard.

The following statement shows approximately the prime cost of tunnel (eight ring work) per lineal yard in good ground, and is exclusive of broken work:—

	Per lineal yard. £. s. d.
Labor—Mining eight-ring work	12 16 6
Brickwork in cement	7 15 10
Setting centres	0 10 0
Junction headings	0 1 0
Bricks, 12,000 at £2 per thousand	24 0 0
Portland cement, bushels 54 at 2s.	5 8 0
Sand, cubic yards 7 at 6s.	2 2 0
Water, 2,000 gallons at 1s. 6d.	0 3 0
Poling boards, 1¼ squares at 11s.	0 13 9
Wedges and foot-blocks	0 3 0
Rakers, props, packings, and sills	0 15 0
Bars, stretchers and props. Renewals of skips, ropes, gins, sleepers, ladders stages. Oil, grease, etc.	0 7 6
Shafts, etc.	2 10 0
Repairs to shafts	0 3 0
Nails, spikes, etc.	0 3 0
	£57 11 3

To ascertain the cost of the tunnel, the mining and brickwork to the extra thickness, the cost of Staffordshire bricks, the cost of broken work including waste of timber, drains, ballasting, tunnel faces etc., must be added. Also deterioration of plant, superintendence, compensations, cost of spoil land, carting earth from the shafts, etc.

The original estimate for the tunnel was £80 per yard, the actual cost was nearly £120. This difference is almost entirely due to the extra thickness of lining, and the cost of blue bricks, and of repairing broken work. The delay caused by the broken work greatly increased the ultimate cost of the tunnel.

THE NEW YORK ELEVATED RAILWAY.

AWARDING THE CONTRACTS.—SEVENTEEN HUNDRED THOUSAND DOLLARS TO BE EXPENDED.

A large meeting of contractors was held October 9, to receive the awards for the construction of the New York Elevated Railroad. The place of meeting was the office of the company, No. 7 Broadway, and there was a full attendance, Mr. Cyrus W. Field, president, in the chair. As is well known, this enterprise, since Mr. Field took hold of it, is endowed with new life. He is believed to have a controlling interest, and is determined to overcome all impediments to the immediate and uninterrupted prosecution of the work. The fact that 81 bids were sent in, responsive to the advertisement for proposals, indicates confidence that it will go forward. Contrary to expectations, no final action was taken at the meeting on Tuesday, as it was impracticable to go through the entire list at a single session, and an adjournment was had until Oct. 11 at 11 o'clock, A. M. Meanwhile all concerned are close-mouthed, and the whole matter stands in abeyance. Mr. Courtright, the chief engineer, remarks, however, that the bids are low, so that there will be a probable saving of some $300,000 on the original estimates of cost, which amounted to $2,700,000. Almost all the heavy rolling-mills of the country are represented, notably those of Pennsylvania and New Jersey. It is also known that a well-known firm in Centre street, New York city, put in bids for the entire work, but no action having been taken, those who put in the estimates are yet in the dark. The company reserve the right of distributing the work among different establishments, so as to secure the utmost dispatch. We learn at the office of the company, in answer to inquiries, that the awards will immediately be made.

Respecting the injunction suit of Rufus Story, now on trial before Judge Robinson, in the Court of Common Pleas, the object of which is to prevent the building of the track opposite his store in Front street, the company expect it will be dissolved in accordance with the decision of the Court of Appeals.

PRESENT STATUS OF THE WORK.

Mr. Field, the president, just before his recent trip to London, in a report to the directors of the company stated that its stock, issued, amounted to $1,063,125, and its bonds to $1,773,000. Its floating debt was $79,000, including a claim in litigation of about $9,000 and the company had in its treasury $227,000 of its bonds. The property of the company consists of its franchises, its railroad tracks extending from the South Ferry to Sixty-first street, with about three miles of siding and second track and a proper equipment of cars and engines.

Mr. Field further states that after strength and safety these being made paramount, the controlling considerations were to devise a plan for the roadway, the supports of which would occupy the least room and be the least in the way, and a superstructure that would intercept the least light possible, and cover only so much of the streets and avenues overhead as was required to support the tracks, as being the least objectionable to the property owners along, and those using the streets through which the road was to be built.

Front and Pearl streets, from Whitehall street to Franklin square, three-quarters of a mile, being narrow, with but little room in the roadway, the columns must of necessity be on the line of the curbs.

From Franklin square to the intersection of the Bowery with Third avenue, 1 9-20th of a mile, along the New and Old Bowery, owing to the number of surface railroad tracks which occupy the roadway much of the distance, and other circumstances, the columns there also will have to be on the line of the curbs.

On Ninth avenue, above Sixty-first street, and on Third avenue, the roadways of which are 60 feet in width, a line of columns is to be placed upon each side of the horse-railroad tracks (where such exist), connected at top of third avenue by light, open, elliptic arch girders, the centre line of the tracks being over the centre line of the columns.

The columns to complete the double track on the present road, west side, will, on Greenwich street, be on the curb, and on Ninth avenue on the roadway, all between and in line with the columns that support the sidings. As the columns and girders are all to be made of open work, to intercept the light as little as possible it is believed the entire structure will present a fair artistic appearance.

ROLLING STOCK AND STATIONS.

The dummies in use generally weigh from 12,000 to 14,000 lbs., with water and coal, and the heaviest draws three loaded passenger cars up a grade of 2 feet to the 100 (which is the maximum the road will have) with ease. To secure ample traction under all circumstances, it is proposed to increase the weight of the dummies to about 16,000 lbs., including water and coal. The platforms, their supports and the stair frames will be of wrought iron, with wooden floors and steps. The station will be small, light and ornamental, the sides and ends covered with corrugated iron the roof with tin.

SPECIFICATIONS FOR THE FOUNDATIONS.

The excavation for the foundations will generally average about 7 feet in depth. The bottom will be covered with a bed of mortar, into which two flagstones of granite 6 inches thick will be embedded, a hole 2¾ inches in diameter having first been drilled through the end of each to receive four anchor bolts 2 inches in diameter, secured by washers under the bottom of the flag-stones.

Where the foundation is rock it will only be excavated to the depth of 2½ feet, provided the rock at that point is sufficiently solid to hold the anchor bolts, in which case four holes of such depth each as may be required by the engineer will be drilled into the rock, sufficiently large to receive the anchor bolts, split at the ends, with a wedge inserted to give them the necessary spread to hold them firmly in the rock.

The bed plates will be of cast iron, weighing about 2,200 pounds each, 3 feet 4 inches square at the base, secured, as before stated, by the anchor bolts to the masonry, having sockets running up 27 inches to receive the channel beams of the columns. Cast iron fenders weighing about 600 pounds each will be secured around the bottom of the columns when in the roadway.

The bed plates and top of the anchor bolts and nuts when in place will be covered on the outer surface by a coat of mortar to protect them from rust, and the space filled between the sockets with suitable material to keep out the water.

COLUMNS AND BRIDGE SUPERSTRUCTURE.

The bridge superstructure will be for two tracks, the material for which, and the columns, when not otherwise specified, will be of wrought iron.

There will be a row of columns generally on the line of each curb from the intersection of Whitehall with Front street, to or near the intersection of the Bowery with Third avenue at or near Fifth street, a distance of about two and one-fifth miles. On Third avenue a row of columns will be placed upon each side of the surface railroad tracks, 22 feet apart in the clear.

From the intersection of Whitehall with Front street to the south end of Franklin Square (through the narrow streets), a distance of about three-quarters of a mile, both tracks may either be placed over the roadway between the columns, or a single track over each side of the street, or a portion of the distance each way at the discretion of the Railroad Company. From the south end of Franklin Square to the intersection of the Bowery with Third avenue, a distance of about one and nine-twentieth's of a mile, a single track will be placed over the curb on each side of the street; on Third avenue a track will be over the centre line of each column over the roadway.

Along such parts of the way between Whitehall street and Franklin Square as the tracks may be placed over the roadway, the columns will be connected at top by transverse girders. Each track will be carried by two lines of longitudinal girders over the roadway between the columns, supported by transverse girders, which latter will rest upon, be supported by and secured to the columns.

Along such portions of the way between Whitehall street and Third avenue, as there are two single tracks, they will generally be over the line of the curbs, one on each side of the street; each track will be carried by two longitudinal girders, supported by a single line of columns; these lines will not be connected with each other, except where crossings may be required, or where it may be thought advisable by the said engineer where the columns are of extreme heights. On Third avenue each track will be carried in the same way; there, however, the columns will be connected by transverse girders.

Each column will consist of 2 15-inch rolled channel beams, generally of 150 pounds weight per yard each (they may be varied somewhat in weight when of extreme lengths, but not beyond what can be done by useing the same rolls), united by lateral bracing 3½x-

⅝ inches, secured by being properly riveted to the flanges of the beams. The channel beams forming the columns will be carried up plumb where the tracks are carried over the roadway between the columns by transverse girders; for the single tracks, and on Third avenue, where the tracks are carried over the line of the columns, they will be curved out from the centre each way at top sufficiently far to receive and support the longitudinal girders, the centre lines of which will be placed about 2½ feet from the centre lines of the columns, one upon each side, to support the tracks.

Cast iron caps will be used to connect the channel beams of the columns at top and for the seat upon them when they are carried up plumb; when they are curved out at top, wrought iron will be used.

Where the seats and connections at top are of cast iron, the beams will be run up into sockets of the cap and will be secured to them by keys or bolts, and the spaces around the beams in the sockets filled with rust joint or other suitable material.

Where wrought iron is used for seats and connections at top, the column head will be formed by riveting to the outside of each flange a plate 8x½ inch, and to the outside of each of these plates an angle iron 4x4x½ inch, all flush with the top. On the bearings thus formed and riveted to the angle irons there will be two plates, 18x26x⅝ inch, on which the longitudinal girders will rest, held in position by angle irons riveted to the plates upon each side of them.

The beams forming the columns will at the base be set into sockets of the cast iron bed plates, extending 2 to 2½ feet below the surface of the sidewalks or pavements and secured by keys or bolts, and the spaces around the beams in the sockets filled as provided for in the cast iron caps.

The dimensions of the straight portions of the columns on Third avenue, where they are in the roadway and connected by transverse girders, and in the roadway of the other streets, will be 15x15 inches. Where the columns are on a line with the curb, not connected at top by transverse girders, the straight portions will generally be 15x18 inches; in extreme heights, up to 15x24 inches may be required.

The height of the columns will not be less than 14 feet above the sidewalks or pavements of the streets except in extreme cases at summits. In a few cases where extreme depressions occur in the streets heights up to 25 feet may be required.

The transverse girders which support the tracks over the roadway between the columns along the narrow streets will be open girders; they will generally be 39 inches in depth in the centre from outside to outside of the pockets which receive the longitudinal girders, from which points the upper chords will slope down and unite with the lower chords over the columns. The top and bottom or upper and lower chords of the girders will each be composed of two 5x5x½ inch angles riveted together, forming a T, united by the pockets, and double bracing of 5x⅜ inches in the centre and 7x½ inches between the girders, the braces placed back to back on the outside of and embracing the legs of the T's, by being all properly riveted together, and the braces with each other at the centre through separators. These girders will be strengthened at top with 12x½ inch and at bottom with 15x½ inch compression and tension cap plates. The spans or lengths of the transverse girders assumed for these specifications are 26 feet 3 inches between centre and centre of columns, which are about the average lengths required across the narrow streets, but will be frequently varied owing to the irregularity in the widths of the streets.

The distance between centre and centre of the two lines of longitudinal girders that rest upon the transverse girders and support the two tracks over the roadway will be 12 feet for spans of 26 feet 3 inches, or under; this distance may, if deemed advisable by the said engineer, be increased for greater spans.

The transverse girders which connect the columns on Third avenue (except where crossings between the tracks are required) will be 34 inches in depth at the ends where they rest upon and are secured to the columns and the longitudinal girders, and about 7 inches in depth at the centre; the top and bottom or upper and lower chords of which will each be composed of two angles, the upper 3x5x⅜ inches, the lower 2½x2½x⅜ inches, united over the columns by angle cross-braces, and between the columns by ⅜ inch plate extending to the top and bottom of the girders between the angles; the braces connecting the chords over the columns will straddle the angles, which will have ⅜ inch filling between them, all properly riveted together. The top of the girders will be straight, the bottom between the columns will form an elliptic arch, with a cast-iron key secured to each side at the centre. Circular openings will be made in the web at each side of the centre, over the spring of the arch.

Where crossings are required between the single tracks and the tracks on Third avenue, the columns will be connected by transverse girders similar in principle to those that are to carry the tracks over the roadways of the narrow streets.

The longitudinal girders will be open and of uniform style over the whole road. They will be 33 inches in depth, the top or upper chords of which will be composed of two 6x6x9-16 inch angles, and the bottom or lower chords of two 6x6x½ inch angles riveted together, each forming a T: the chords united by double angle braces 5x3x7-16 inches at the ends and 4x3x7-16 inches in the centre, placed back to back on the outside of and embracing the legs of the T's by being properly riveted together, and with each other at the centre through separators.

Where these girders are carried by the transverse girders over the roadway between the columns, one end of each will be riveted to one side of the transverse girder, and the other end will rest in a pocket on the other side, with proper division for expansion. Where they are over the line of the columns, the ends will rest upon and be secured to the seats on the tops of the columns and connected by expansion plates.

The girders under each track will be placed 5 feet from center to center, connected by lateral angle bracing 3x3x⅜ inches at top, and 2½x2½x⅜inches at bottom, properly riveted to the upper and lower flanges of the chords.

The ends of all longitudinal girders, except where riveted to the cross girders, will be secured in an upright position by vertical cross bracing, or otherwise.

The lengths of the longitudinal spans assumed for these specifications are 43 feet 4 inches, (multiples of the blocks and cross streets in the regularly laid out parts of the city) but may be longer or shorter, as required to suit the variations in the lengths of the blocks, and other circumstances.

In cases of any considerable variations from the assumed lengths, 43 feet and 4 inches of spans, the dimensions of the angles forming the chords of the girders will be varied approximately, but not beyond what can be done by using the same rolls; and in extreme lengths they will be further strengthened—if deemed necessary by the said engineer—at top and bottom by compression and tension cap plates.

The angle irons for the chords of all the girders will be the full lengths of the spans without splice. The channel beams, forming the columns, when being bent out at top for the support of the tracks over the columns, will be at a red heat, so as not to impair the fiber of the iron.

The members and fastenings of the bridge superstructure are intended to be as nearly as practicable so arranged, and their dimensions so proportioned, that no part of them shall be subjected to a greater strain of tension or compression than 8000 pounds to the square inch, or subject to a greater shearing strain than 6000 pounds to the square inch, with either a moving load in addition to its own weight of 12,000 pounds per lineal foot distributed for each track, or with 16,000 pounds in addition to its own weight on the four locomotive drivers on 5 feet wheel base, with a passenger car when loaded weighing 24,000 pounds, being 12,000 pounds on the four wheels of each truck on 4 feet wheel base; trucks 28 feet from center to center, and 14 feet from center of locomotive bearing to center of nearest truck. The transverse girders are to be of equal strength with the longitudinal girders, as measured by actual load.

The maximum deflection of any girder under the passage of a train not to exceed one fifteen-hundreth part of its length.

All of the material for the columns and bridge superstructure, including the anchor bolts, is to be of wrought iron (except where cast-iron connections and caps are used in the columns), and shall be of the following general character; tough, highly fibrous, and of a quality which shall in every respect be equal to that used in first-class American iron railway bridges. In its manufacture no old or scrap iron to be used. The channel beams, angles, plates and bars, shall be of such quality of iron that test pieces cut from any part during manufacture shall be capable of bending cold to a right angle without cracking, and shall have an ultimate tensile strength of not less than 50,000 pounds to the square inch, and its elastic limit such that no appreciable set will take place under a less strain than 25,000 pounds to the square inch, provided that all rivets shall be of double refined iron, which shall have an ultimate tensile strength of 60,000 pounds to the square inch, and capable of bending double when cold so that the sides shall be in contact without cracking. All strength tests to be made in bars and rods of uniform sections and in such manner as shall be prescribed by said engineer. The cast iron is to be made of good tough Lehigh pig metal, subject to the approval of said engineer. Any material which in the opinion of said engineer does not come up to the standard herein specified, will be rejected.

The ends of all braces and tension bars must be planed to a line so as to make a close fit with the iron against which they abut.

All rivet holes shall be truly spaced and punched, and no drifting will be allowed. Riveting at works shall be done by pressure when possible, so that all rivets shall truly fill their holes. Riveting at site shall be carefully and accurately done, and all heads shall be well formed. Rivets to be put in at red heat.

TRACK SUPERSTRUCTURE.

The material for the track superstructure will consist of Georgia or Florida yellow pine cross ties, 7 feet 9 inches in length and 5x6 inches in diameter; longitudinal guards in length of 45 feet or over as they can be obtained, and Bessemer steel rails, 50 pounds to the yard, with necessary fastenings.

The guage will be 4 feet 8½ inches.

The cross ties will be placed 10 inches apart in the clear; the ends will rest upon and be secured to the longitudinal girders by lag screws with washers at bottom, the latter projecting under the top flanges of the girders, clamping the ties to them.

Each guard will be bolted to every alternate tie, and each tie bolted by two bolts to the guards.

The guards will be 4 inches in the clear from the rail, secured to the ties and to each other at the ends by dove-tailed splices of not less than a 9 inch lap, and bolted together. The position of the rail over the girders on curves will be varied, and the outer rail and guards raised to suit the curves by tapering the ties.

The plans and specifications of the road to complete the double track along Greenwich street and Ninth avenue will be similar to those herein provided for a single track on the east side of the city, with the exception that close girders will be used where there are none on the columns now in place at the ends of the sidings, similar to those on the sidings.

On the last columns at each end of the sidings, where the open girder will commence and where there is sufficient head-room to put the full depth of 33 inches, or any greater depth than the girder with which it connects, the end of the girder will be made of the same depth as the connecting one by bending the lower flange up to the necessary point, properly braced and stiffened at the end. Where there is not sufficient head-room between the present sidings to get a 33 inch depth of girder and preserve a proper line of surface and grade on top, the depth will be reduced as circumstances may require, uniformity being preserved as far as possible. Whatever changes may be required to make a proper connection between the new girders and the old ones on the sidings will be at the expense of the contractor without extra charge.

The columns on Greenwich street will be on the line of the curb, and in Ninth avenue in the roadway, all in line with the columns that support the sidings.

The plan for the double-track road on Ninth avenue above Sixty-first street will be similar to that provided for Third avenue, dispensing with the transverse girders if deemed advisable by said railroad company.—*The Iron Age.*

TURNPIKING AND UNDERDRAINING COMMON ROADS.

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In this article it is proposed to briefly discuss the various methods of providing an escape of the surplus water from roads. The methods recommended here are valuable only when applied as here designated. It is not claimed that the removal of the water will, in all circumstances and under all conditions, render a road good; but it is claimed that this is an essential condition to the making of a good road, and one which if not provided by nature must be provided artificially.

The systems of turnpiking and under draining are fully considered, but metalling, that is, applying a road covering, as gravel or broken stone, though strongly recommended, is not treated of in this article.

IMPORTANCE OF ROAD DRAINAGE.

The principal cause of poor roads on all heavy soils is an over-abundance of water, which renders the road wet, soft, and at times totally unfit for travel; consequently we find that the road makers in all ages have strongly urged the adoption of some efficient method of removing the surplus water. For instance, McAdam, in his report to the British Board of Agriculture (Vol. VI., p. 46) says, "Roads can never be rendered perfectly secure until the following principles be fully understood, admitted, and acted upon, namely, that it is the native soil which really supports the weight of traffic; that while it is preserved in a dry state it will carry any weight without sinking, and that it does, in fact, carry the road and carriages also; that this *native soil must previously be made quite dry*, and a covering impenetrable to rain must then be placed over it, to preserve it in that dry state; that the thickness of a road should only be regulated by the quantity of material necessary to form such impervious covering, and never by any reference to its own power of carrying weight. There are some exceptions to this rule. A road of good naturally binding gravel may be laid on a sub-bed of bog-earth, which from its tenacity will carry all kinds of carriages for many years."

DIRECTIONS FOR PREPARING MACADAMIZED ROAD.

Mr. McAdam, in describing the method of preparing a road-bed, says: "The first operation in making a road should be the reverse of digging a trench. The road should not be sunk below, but rather raised above the ordinary level of the adjacent ground; care should be taken at any rate that there be a sufficient fall to take off the water, so that there should always be some inches below the level of the ground upon wh ch the road is intended to be placed; this must be done either by making drains to lower the level of the water, or if that be not practicable from the nature of the country, then the soil upon which the road is proposed to be laid must be raised by embanking so as to be some inches above the level of the water. *Having secured the soil from under water*, the road maker is next to secure it from rain water by a solid road made of clean, dry broken stone or flint (none of the fragments of which to be greater than two inches in diameter), so selected, prepared, and laid as to be impervious to water; and this cannot be effected unless the greatest care be taken that no earth, clay, chalk, or other matter that will hold or conduct water be mixed with the stone, which must be so prepared and laid as to unite with its own angles into a firm, compact, impenetrable body."

Another practical road maker, Mr. Patterson, of Montrose, of the same age as Mr. McAdam, commends the principles proposed by Mr. McAdam, but objects, as we think with reason, to his drainage of three or four inches as being insufficient.

TELFORD ROADS.

Again Telford, whose roads, to-day are the best that England possesses, laid great stress in all his *practical* operations upon thorough and complete drainage. His roads are made of layers of broken stone resting upon a sub-pavement of stone blocks. Telford's specifications for a roadway of 30 feet were as follows: "Upon the level bed prepared for the road materials a *bottom or layer* of *stones* is to be set by hand in the form of a close, firm pavement. The stones set in the middle of the road are to be seven inches in depth; at nine feet from the centre, five inches; at twelve from the centre, four inches; and at fifteen from the centre, three inches. They are to be set on their *broadest edges and lengthwise across the road*, and the breadth of the upper edge is not to exceed four inches in any case. All the irregularities of the upper part of the said pavement are to be broken off by the hammer, and all the interstices to be filled with stone chips, *firmly wedged or packed by hand* with a light hammer, so that when the whole pavement is finished there shall be a convexity of four inches in the breadth of fifteen feet from the centre. This pavement is to be coated with stone broken as nearly as possible into cubical pieces, whose edges must not exceed 2½ inches in length, and which must be applied in layers over the remainder of the pavement so as to make the whole convexity of the road six inches from the center to the sides of it, the whole to be covered with a depth of one inch and one-half of good clean gravel.

"The advantages of this system are most striking when the natural soil is retentive of moisture, as where it is clay the pavement then acts as an underdrain to carry off the water which may find its way through the broken stone surface. Even on a rock this pavement may be laid with advantage to form a dry floor."

WALKER'S SYSTEM.

A dry foundation and clearing the road from water are two important objects which, according to Walker (minutes of evidence before a committee of the House of Commons, 1819), ought to be kept in view in laying our roads. "For obtaining the first of these objects it is essential that the line for the road be taken so that the foundation can be kept dry, either by avoiding low ground, by raising the surface of the road above the level of the ground on each side of it, or by drawing off the water by means of side drains. The other object, viz., that of clearing a road of water, is best secured by selecting a course for the road which is not horizontally level, so that the surface of the road may in its longitudinal section form in some degree an inclined plane; and when this cannot be obtained, owing to the extreme flatness of the country, an artificial inclination may generally be made. When a road is so formed, every wheel track that is made being in the line of the inclination, becomes a channel for carrying off the water much more effectively than can be done by a curvature of the road without the danger or other disadvantages which necessarily attend the rounding of the road much in the middle. Walker considered a fall of about one inch and a half in ten feet to be about a minimum in this case, if it is attainable without a great deal of expense."

It may be remarked concerning the theory proposed by Walker for surface drainage, that though it might effectually secure that object, it would, if the road be too steep, not only increase the draught of vehicles passing over, but the surface would suffer greatly from being washed. For instance, the minimum inclination allowed by him of one and one-half inch in ten feet, or of one foot in eighty, would give a velocity to the water flowing down of about one foot per second, provided the water is one-eighth of an inch in depth, which would be sufficient to move fine gravel, and consequently injure the surface very much, while a greater inclination would affect it much worse. Although the grade proposed is lighter than many that are retained on good roads, still when the choice lies between level roads and roads of this inclination, level roads are always to be preferred, since the draught over them is one-eightieth lighter than over roads having this inclination, and other methods equally effectual can be found of removing the surface water.

The methods previously described of constructing roads as prescribed by McAdam and Telford have been adopted and carried out to a great extent in making the roads in Great Britain and in some portions of this country. Long and constant use has demonstrated that the principles promulgated by McAdam are sound and reliable only to a certain extent. It is to be noticed further that in McAdam's directions for preparing a road-bed he makes slight provision for drainage, a condition which he admits to be of much importance when stating the principles on which he thinks the construction of good roads depends; Telford, on the other hand, though saying very little about the *great* importance of drainage, makes thorough provision for it by his pavement of large stone, through which the water passes as though it were a sieve, leaving the road high and dry. Again, it is very much to be doubted that a road covering entirely impervious to water can be formed as McAdam in his directions indicates. McAdam gives one or two instances where the road covering has preserved the road-bed beneath perfectly dry. But from some statements he makes regarding the comparative merits of the roads constructed by him and by his rival Telford, we must conclude that he changed his mind respecting the power of broken stone to resist the permeating force of water. Telford prepares a different foundation but uses a road covering in every essential the same as that proposed by McAdam. Yet of these roads McAdam says the water passes through as readily as through a sieve, a statement entirely incompatible with the one "that a broken stone road is impermeable to water." Although no road covering is entirely impenetrable to water, yet a good compact covering of either broken stone or gravel, properly rounded in the centre, will convey a very large per centage of the water that falls upon it to the sides of the road, while a flat surface of either broken stone or gravel will soon absorb water and become soft and muddy. The Telford roads are much better than the McAdam roads, especially where the McAdam roads have been built over low ground with no more provision for drainage than given in the original directions of McAdam, simply because Telford prescribes a better drainage for the road foundation in his directions.

Thus it is seen that thorough drainage of roads has always been and still is of great importance in road construction, and, second, that the best road coverings cannot be made entirely impervious to water.

METHODS OF DRAINING ROADS.

The next questions that naturally arise are regarding the methods of draining roads. The methods of the great English road builders have been fully stated, but on account of the great cost of these roads, for the time being at least, we will have to content ourselves with cheaper roads. Whatever system of road making is adopted, it should be one that will keep our roads constantly improving, and one that does not demand very costly annual improvements to keep them steadily growing better. It is a well known fact that if means are provided for the escape of water, even though no broken stone, gravel, or other road covering be applied, the road will be greatly improved. A dry, smooth road on clay or loam (roads on dry sand not referred to in this article) is always in a good condition, and the nearer dry a road on heavy soil can be kept the better will it be. The common means resorted to for removing the water is by turnpiking, ditching, and by underdraining. These three methods we will consider somewhat in detail.

TURNPIKING.

Turnpiking is performed by excavating ditches at the sides of the road and throwing the earth obtained from these into the center forming an elevated ridge on which the roadway is formed. The roadway being elevated above the side channels the water passes from it partly by passing through the surface of the road and working its way through the ground until it reaches the side channels, and partly by running directly down the slopes of the roadway into the side channels. The efficiency of the turnpike depends upon its dryness; for when heavy soils are saturated with water they become soft and incapable of supporting a heavy load, consequently it becomes evident that the surface of the turnpike should be made of such shape as to allow as little water as possible to permeate the surface, and it should convey as large a per cent. as the conditions will allow directly to the side channels, which should be made so as to convey the water that passes into them completely and rapidly away.

SLOPE OF THE ROADWAY.

The slope that may be given the surface depends somewhat upon the nature of the soil and the character of the travel that passes over the road.

The steeper the surface the less water will it absorb, but if it be made too steep, the water passing over it will wash much earth into the side channels thus rendering them comparatively useless as well as endangering the safety of the travelers who drive near the side of the road. The exact slope that will best suit all cases cannot definitely be stated, but experience has

shown that a rise of one inch for every three feet measured horizontally answers the required conditions very well for the road bed. The slope of the side of the road to the ditches should be little more than one inch to the foot, while a steeper slope, for instance one that rises four inches per foot horizontally, will do for the side of the ditches next the road side fences, as they are less likely to be cut or trampled out of shape by passing vehicles. The usual practice in turnpiking is to make a road with the side slopes and cross section as shown in Fig. 1.* the objections to which are evident and may be concisely stated as follows: The side ditches have steep sides, their deepest portions are next the roadway, the road is narrow,—travel is kept in one place,—it is difficult and often dangerous to turn out; the road soon becomes rough and rutted, and bears deep mud holes on its upper surface, as scarcely any water can reach the side channels without first passing through the soil of the roadway itself.

The side of the roadway should be sloped from the centre, gradually increasing in steepness to the bottom of the ditches, so as to give the water the greatest rapidity, where its washing will do the least hurt. Practically it will answer every purpose to make the sides of the ditches uniformly ascending planes, which are curved to meet each other after reaching the road bed. Fig. 2 shows the proper form of a turnpiked road; the dotted line marks the position of the original surface of the land, the portion above the dotted line the *roadway*, the light portion below the dotted line the *side ditches*, which have been excavated in forming the roadway.

The width of the roadway (that portion above the dotted line in Fig. 2) should be made to depend upon the amount and character of the travel that passes over the road. A roadway of twenty-five feet in width will probably accommodate any traffic that passes over or may be expected to pass over any country road in this State. It is doubtful economy to construct a road less than sixteen feet under any circumstances, while a roadway of twenty feet will probably answer well for all roads except such as have an exceptionally large traffic over them. A roadway of twenty feet will afford ample room for two teams to meet, even when loaded with unusually wide and bulky articles, as for instance with hay, for wagons are usually less than five feet wide, and racks do not project over four feet on each side, making the total width thirteen feet; if the outer wheel of each wagon be driven on the edge of the road-bed the track will project four feet over the slope of the ditch, and there will be a clear space of two feet between the racks. Even if they drove down on the side there would be little or no danger of tipping over. The *ditches* or *side channels* should have a concave surface; cut of No. 3 shows a desirable form of cross-section; cut No. 4 shows the ordinary undesirable form.

They also should have a continuous ascent from the outlet to the highest portion of the road, and the outlets provided should be of sufficient size to allow all water that passes down the side channels to pass through at once into water courses or suitable reservoirs, where its presence will not affect the road.

The depressions that occur on the line of almost every road, mark the position of ravines or water courses that make an angle with the axis of the road, and which afford excellent means of emptying the side channels.

On roads over flat, low or marshy grounds, it is of vital importance to the condition of the road that the side channels be provided with ample means of allowing the water to escape.

To prepare these outlets in such cases, will often need long lines of ditches which empty some distance from the road, and can be prepared only at great expense. Where low or marshy lands cannot be ditched and the road cannot be turned so as to avoid them, it is doubtful if a permanent road can be built; but a very good road can be built by laying parallel to the axis of the road three logs as nearly as possible of the same diameter. On these lay cross logs of uniform diameter and not less than sixteen feet long. Then fill in the interstices of these cross logs with poles from one to three inches in diameter, on top of which lay a layer of fascines (brushwood bound in bundles with withes) six inches deep. Cover the whole with six to eight inches of sharp coarse gravel, and a road will be formed that will remain in very good condition for a considerable length of time, even over very soft ground. Such a road it is hardly possible to build except where timber is very plenty, on account of the great amount required in its construction.

*The illustrations to this article will be presented in our next.

IMPLEMENTS NEEDED.

The implements which above all others are best adapted for this work are the *road scraper* and the *plow*. The plow requires no special mention here. The road scraper should have more width in proportion to its depth than in the ordinary land scraper. Instead of having the bottom rounded in the usual manner it should be made perfectly flat.

The scraper owned by the college was made at Dearborn, Mich., and although not so well adapted for a road scraper as some made for that especial purpose, it is a great improvement over the ordinary land scraper. It is slightly rounded on the bottom, it has a cutting edge of fully four feet; it is two feet from the cutting edge to the back of the scraper; the back is eight inches wide, and makes an oblique angle with the bottom. The handles are fastened as in ordinary scrapers; they are of two feet in length, and are connected near their free extremities by a round bar of wood. The cost of the scraper was ten dollars.

The Chicago Scraper and Ditcher Company make an excellent form of road scraper, which they guarantee to be made of best materials, and of approved workmanship. These scrapers have proved highly satisfactory, so far as I can learn, to all who have tried them. The price certainly is very reasonable. At a competitive test under the auspices of the Agricultural Society of the State of Illinois, at Roberts, in Ford county, Ill., August 11th and 12th, 1875, a road* eighty rods long and thirty-nine feet wide from ditch to ditch, was made at a cost of less than seventeen cents per rod, calculating man and team at three dollars per day.

(*To be continued.*)

*This road was of the same form, in most particulars, as the one described, and had a road-bed of twenty-five feet in width.

COL. ARTHUR ON RAILROAD MANAGEMENT.

Col. W. R. Arthur, General Manager of the St. Louis, Iron Mountain & Southern R. R., has given some rather new and startling theories relative to railroads, and systems of railroads in this country, which are reported as follows in the St. Louis *Republican;*

The failure of many railroads may be found largely in the fact of their not conforming in location and construction to laws governing the direction of trade. There are other causes of financial failure—such as mismanagement, extravagant construction, and the building of lines not required by the demands of commerce—which are not only necessarily failures in themselves, but embarrass legitimate enterprises. The traffic of this continent seeks great centres, and lines of communication between these centres are necessary and can be made useful and profitable. Any others will be of local accommodation and convenience merely, and seldom directly remunerative. Exceptions may exist where large local productions are found.

The direction of traffic is from the producing to the consuming points. In so great an extent of territory many centres will be or are established for the convenience of transacting business, and which are determined by physical or geopraphical advantages. The great centres of concentration for consumption and exportation of the agricultural products of the country are New York, Philadelphia, Boston and Baltimore. These are the *foci* of the great systems of railways of the country. There are other minor points for exportation of the special products of the South. These major points are also centres for the collection of merchandise and manufactures for distribution.

The great centres for collection and distribution in transit would be St. Louis, Chicago, Pittsburg, and Buffalo. There are subordinate centres (I mean centres of railway systems) such as Milwaukee, Kansas City, Indianapolis, and Louisville. To these centres systems of transportation belong. The west and northwest of the south end of Lake Michigan belong to Chicago; the west and southwest of St. Louis to St. Louis; for the South, Louisville and Indianapolis become the culminating centre of the Southern system.

The Milwaukee system is subordinate to Chicago; Kansas City to St. Louis. Pittsburg and Buffalo are secondary and common to all the others. Any line of road from the centre of one system into or across another will be worked at a disadvantage. A conflict will follow which will result disastrously to the invader.

Lines between centres are necessary and can be made profitable. Lines from Chicago to the Southwest or from St. Louis to the Northwest, under the present condition of the navigation at the mouth of the Mississippi River, will labor under great disadvantages. Lines southeast from Chicago, or northeast from St. Louis, not connecting directly with one of the centres named, will be alike unfortunate. Lines southeast from St. Louis or Kansas City will not meet with success. Lines from Louisville or Indianapolis connecting with the Southwest system at any point south of St. Louis will do so with great odds against them. There are other inferior centres and systems to which the same rules will apply.

The correctness of the foregoing assertions, if not apparent are of easy demonstration from the laws of trade or the practical workings of existing lines. It would be invidious to instance examples, but a moment's reflection by the well-informed will enable them to point out the lines not in accord with the centre system. Capital should avoid all lines not in harmony with systems. Boldness of enterprise, with boldness as its only merit, will hardly conquer or achieve success.

CORRESPONDENCE.

FERRYSBURG, MICH., *Oct. 20th, 1877.*

Editor ENGINEERING NEWS:

Sir.—The scheme proposed in the last number of the NEWS, by Mr. Emerson, for finding the "thread" and velocity of a stream or river current, is ingenious, and in the main excellent; but is far from being as new as he may think.

The fundamental idea of finding the consecutive positions of a moving point, by means of a position angle, at the objective point, and a fixed and known line, with co ordinate angles at its extremities, is as old as the art of hydrography.

But, whoever may have had occasion to report the problem, should avoid the arrangement of the transits adopted by Mr. Emerson, which is the worst that could be made, possibly, as a little consideration will show. By making the reference-line, *i. e.*, the line joining the centres of the transit, cross the river, the buoy carrying the flag, to be observed upon, may cross this line; in which case, its place, when on the line, becomes *indeterminate*. For, in nearing the reference-line, the position-angle becomes very obtuse, and as a consequence, nonprecision begins to creep into the result of the observation. This nonprecision increases as the object nears the reference line, till it is on that line, when the position angle vanishes,—the two lines containing it, become one with the reference-line, and, as a consequence, the place of the objective point on that line is lost,—because it becomes indeterminate.

The reference-line, should be so located, with regard to the current to be surveyed, that the position-angle can never be less than 30°, nor more than the supplement of 30°, or 150°. This condition is best attained with *both transits on the same side of the river.*

H. C. PEARSONS.

OFFICE OF DALLAS WATER SUPPLY COM'Y,
DALLAS, TEXAS, *October 17th, 1877.*

Editor ENGINEERING NEWS:

Sir.—Being a subscriber of your paper, I take the liberty to enquire of you concerning some matters of municipal duty and individual rights as affects the natural drainage of a city.

We have in Dallas a rapidly growing community, and the city is fast spreading out over more territory than our finances can take care of in the way of street improvement and drainage. We do everything on a cash basis and pay as we go, issuing no bonds, no scrip, or notes, and consequently cannot improve the city as fast as we would like.

Among the many questions which arise in making improvements are, what is the duty of the city in regard to taking care of the rain-fall, when the natural drainage is over and through private property? Can the property owner fill up his lot and throw the water on his neighbor, or in the street, or must the water-way be kept open as it was, and is the city compelled to confine the water-way to its original bounds, and see that it does not damage private property?

Must the city at its own expense wall in and pave all the natural drains in its limits? If so, then we, having some five miles of such, can never afford it; or, can not the property owner be compelled to leave the water-way open, and wall it in and pave it at his own expense?

We have no sewers, only gutters, and one covered drain for surface drainage. Can you refer me to any authorities on such subjects? Is there any court decision on such matters?

An answer to these questions will be highly appreciated, as we want to know just what is our duty, and what is the law.

Yours Truly,
W. M. JOHNSON, *City Engineer.*

We will be obliged if any of our readers who have been called upon to investigate the questions proposed in the above correspondence will give such information for publication as he may be possessed of.—ED.

BOOK NOTICE.

ELEMENTS OF DESCRIPTIVE GEOMETRY, SHADOWS AND PERSPECTIVE. By S. Edward Warren, C. E. New York: John Wiley & Sons. 1877.

We have carefully looked through this latest work of Prof. Warren, who has been long and favorably known by his books treating of the different divisions of en-

gineering drawing, and have found in it many things to merit our warm approval. We have felt that his previous series upon descriptive geometery, shades and shadows, linear perspectives, etc., were too bulky to be entirely satisfactory for class-room work, however excellent they might be for reference and private study. That this view, even if not adopted, has been duly considered by the Professor is seen from the introductory sentence of his preface. "This volume, entirely new, and not abridged from any larger ones, was prepared partly to meet an evident demand for brief text-books."

Of the 282 pages of text, some 185 pages are devoted to descriptive geometry proper, 35 pages to shades and shadows, 35 pages to linear perspective, and the balance to spherical projectio is, trihedrals, axonometric and oblique projections. There is even now, in its condensed form, more in the book than some classes can go over carefully in the time which is usually allotted to this study, but, as a mathematical professor once said to us, we "prefer to use such a book that a class at the close of their study shall not think they have learned all there is to be known about the subject."

As any readers of Professor Warren's text-books well know, he is very systematic, and rather delights in a synopsis or chart of the different steps or processes. This feature is not brought out so strongly here as usual, yet the work is well classified. His placing of warped surfaces in the category of single curved surfaces, restricted as undevelopable, struck us at first as going counter to our notions, but on reflection we were obliged to yield.

The method in which he handles the various problems is excellent, and a most admirable feature, which alone ought to commend the book to all, is the abundance of examples for practice, several following nearly every problem. For class-room work any teacher will find these examples most serviceable.

The plates, 24 in number, are bound by themselves, in flexible covers, and may be slipped in at the back of the book, so that one has but a single volume to carry, while the plates can be placed with any portion of the text for reference. The print is very clear, the book is gotten up in good style, uniform with the Messrs. Wiley's later scientific publications, and the price, $3.50, makes it cheaper than some of the kindred text-books at present in use.

PUBLICATIONS RECEIVED.

Journal Zodtchy, St. Petersburg.

Ze tschrift des Oesterreichischen Ingenieur—und Architekten, Vereins, Vienna, Austria.

Report of the Michigan Board of Agriculture, for 1876.

Report of the Mississippi Jetties, by Capt. M. R. Brown, U. S. E.

Transactions of the Society of Engineers of Paris, July and August.

The *Nursery* for November.

Harpers Monthly for November contains the following:

Ten Year's Acquaintance with Alaska—H. W. Elliott. Palingenesis—A Poem—Ellis Gray. The King of Conjurers—Olive Logan. San Antonio de Bexar—Harriet Prescott Spofford. Contentment—A Poem—Helen S. Conant. Madelena—A Story—Mrs C. V. Hamilton. Yachting in Blue Waters—T. Robinson Warren. The Best Gift—A Poem—Kate Hillard. Back to Back—A story of To-day—Edward Everett Hale. A Study—A Poem—Phillip Bourke Marston. Erema; or My Father's Sin—R. D. Blackmore. To a School-Girl—A Poem—Fannie R. Robinson. A Year of American Travel—Jessie Benton Fremont. The Miners of Scranton—Phœbe E. Gibbons. My Mother's Objections—A Story—Henrietta Holdich. Editor's Easy Chair. Editor's Literary Record. Editor's Scientific Record. Editor's Historical Record. Editor's Drawer.

The *Atlantic Monthly* for November contains:

The Queen of Sheba—Thomas Bailey Aldrich. Survival of the Fittest—C. P. Cranch. The American Iron-Master's Work—R. W. Raymond. The Sailing of King Olaf—Alice Williams Brotherton. Portugal and the Portugese—S G. W. Benjamin. 'Ah, Chasms and Cliff's of Snow"—Mrs. S. M. B. Piatt. Crude and Curious Inventions at the Centennial Exhibition—Edward H. Knight. Kathern—Fearn Gray. Some Aspects of DeQuincey—George Parsons Lathrop. Autumnal Poems: Indian Summer—Edgar Fawcett; The Rose in October—Mary Townley; November—C. L. Cleaveland. Some Rambling Notes of an Idle Excursion—Mark Twain. Fictitious lives of Chaucer—T. R. Lounsbury. Carlo Goldoni—W. D. Howells. In The Old South Church—John Greenleaf Whittier. The Contributor's Club. Recent Literature. Education.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

W. K. Ackerman, Esq., late Vice-President of the Illinois Central R. R., was this week elected President of the Company. This appointment by the I. C. R. R. Company is a fitting tribute to well deserved merit and a just acknowledgment of the invaluable services rendered by Mr. Ackerman.

H. E. Sargent, formerly General Superintendent of the Michigan Central Railroad, a gentleman of experience and ability, has been offered the General Managership of the Northern Pacific Railroad, and has gone to New York to arrange for pushing the road to an early completion.

Col. Thomas R. Sharp, Master of Transportation of the Baltimore & Ohio Railroad, has been elected President of the Long Island Railroad, and will sever his connection with the former road. W. M. Clements, who has already assumed Col. Sharp's duties, will be elected to succeed him.

The Secretary of the Navy recently constituted a special board to examine the calculations connected with the construction of the great iron-clad, the Puritan. He decided to add to the navy officers on the board, three engineers from civil life. The three selected were Capt. Eads, well known for his success in improving the mouth of the Mississippi, State Engineer Van Buren and Professor Thurston of the Stevens Institute at Hoboken. Mr. Van Buren, finding the first meeting of the board called during a period which he had already assigned for his inspection of the Western division of the canal, was unwilling to postpone his engagements for duty in the State, and fearing it might otherwise interfere with his official time and attention, declined the appointment.

BRIDGES.

The contract for constructing a wrought iron bridge across the Genesee river, Spenceport, near Fowlerville, New York State, was awarded to the Wrought Iron Bridge Co,, Canton, O. The specifications called for a structure of 230 ft. span, with a roadway of 16 feet in the clear and a weight capacity of 60 lbs per square foot of roadway exclusive of weight of bridge. Strains not to exceed for tension 12000 lbs, compression 9000 pounds per square inch. The bridge to have iron floor beams, and not less than 16 panels. The floor plank to be supplied by the commissioners but laid by the contractors. The following bids were received. Wrought Iron Bridge Co. Canton, O. $27.-55 per lineal foot for double intersection truss with pin connections. Niagara Bridge Co. Buffalo N. Y. $27.90 per lineal foot for lattice truss. Kellogg Bridge Co. Buffalo N. Y. for pin connection truss. Penn. Bridge Co. New Brighton, Pa., $26.30 for pin connection truss. King Bridge Co., Cleveland, O., $33.00 for pin connection truss. Leighton Bridge & Iron Works, Rochester, N. Y. $25.65 for lattice truss. Smith Bridge Co., $26.79 for pin connection truss. Morrison, Field & Co. Buffalo N. Y. $25.90 for pin connection truss. Massillon Bridge Co., Masillon, O., $26.70 for pin connection truss.

The Clinton Bridge Co., of Clinton, Iowa, is now engaged in erecting, and under contract to complete before Jan. 1st 1878, the following bridges, for the Dubuque & Minnesota R. R. Co. "Howe Truss Combinations" as follows: 1 span of 105 feet, 2 spans of 119 feet each. 1 span of 160 feet 2 spans of 120 feet each, 4 spans of 110 feet each, 3 spans 80 feet each. Also, for the Chicago & Pacific R. R. Co. at crossing of C. & N. W. R. R. at Elgin Ill., 1 span combination. Also, 2 spans of 165 feet each, Iron trusses at Fort Dodge, Iowa. Also, 1 span 80 feet iron truss in Nebraska. Also 5 spans 60 feet combination in Nebraska; also, 1 span of 100 and 1 span of 70 feet in Boone county Missouri; also, 1 span of 160 feet iron truss at River Falls, Wisconsin; also, 2 spans of 120 feet each, iron trusses at Shell Rock Butler county, Iowa, to be placed on tubular iron abutments and piers; also one span of 137 feet iron truss on tubular iron abutments in Cherokee county, Iowa; also 1 span 160 feet iron truss on tubular iron abutments at Menominee, Wisconsin.

GAS AND WATER-WORKS.

The Alton, Ills., gas company wants to renew its contract with the city at $4 per 1,000 feet, but the people say nix.

The city of LaSalle, Ills. had a gas fight on its hands. The council refuses to pay more than $3 per thousand feet for gas used in the street lamps, and the local gas company has struck, and refuses to lightthe street lamps.

Several large dealers in gas fixtures of Detroit visited Lansing, Mich., last week and displayed their wares before the Board of State Auditors who are now considering the question of furniture and lighting arrangements for the new capitol. Proposals for this work will be invited within a very short time.

The city council of Springfield, Ills., have opened the bids for lighting the city, and report that the new gas company offer to furnish gas at $2.24 per thousand, or light the street lamps for $19.50 per annum each. The council rejected the bid and will advertise in Eastern papers for proposals.

The Board of Water Commissioners of San Francisco on Oct. 18 formally accepted the proposition of the Blue Lakes Water Company to bring water to the city for $13-500,000. As soon as the necessary preliminaries are accomplished the question will be submitted to the people.

The suggestion for increasing the water supply of New York city, by reopening the old wells and pumps, of which there are a large number in that city, is opposed by Allan Campbell, Commissioner of Public Works, on the ground that it would be detrimental to the city's health. He adds, however, in his communication to the Board of Aldermen, that it might be well to have a few of these wells driven, to test their capacity for supplying steam engines.

RAILROADS.

The contract has been closed to build the proposed narrow-guage road from Rennsselaer to Bradford, thence to Delphi, and eventually to Indianapolis, Indiana. The first section, sixteen miles, between Rensselaer and Bradford, is to be completed in sixty days. The distance from Rensselaer to Indianapolis is 155 miles. The contractors have agreed to build the entire line within the next eighteen months if a certain amount of money per mile is raised. Thus far but $150,000 have been secured to carry on the enterprise.

Oct 18th at Wheeling W. Va., the West Virginia Central Railway Co. capital $10,-000,000 was incorporated. The road is from Caredo, Upshur county, W. Va., through the counties of Cabell and Putnam crossing the Great Kanawha river at the city of Charleston, Kanawha county, thence along the river to the mouth of the Gauley river: thence along the Gauley river to a point near its source, passing through the counties of Kanawha, Fayette, Nicholas, Webster, Pocahontas to Harrisburg, Va., and thence through the counties of Madison, Culpepper, Farquahar, and Stafford, to Ague creek, on the Potomac river, a distance of three hundred miles. The stock is owned by Philadelphia capitalists.

[Special Correspondence.]

DETROIT.

One of the earliest of the French settlements west of the Appalachian chain, a city of nearly one hundred thousand inhabitants, Detroit in many respects is the handsomest city in America. As soon as it began to assume proportions of importance it was laid out on the "plan of self-defense," with important streets radiating from central plazas. But the restless burghers were far too enterprising for the sleepy city fathers of ye ancient time and noble lineage, with the conservatism which hard-earned dollars beget, and the "plan of self-defense" extended but a few blocks from the *Campus Martius*, ere land-owners laid out their property to the best advantage on the inevitable rectangular system, and held it at prices beyond the reach of the municipal pocket.

Although the plan was abandoned, still Detroit is more than ordinarily well laid out for a chance city, and the many well paved, broad and shaded avenues bordered with fine residences make of it a beautiful city. We find no special quarter in which "money bags" erects his mansions as along Euclid Avenue in Cleveland, or the few fine streets of other cities; but wealth seems uniformly distributed in fine residences and grounds along many avenues.

Detroit has its plague spots however. The old French colonial grant in this country usually had a narrow front of a few rods on navigable waters and extended back indefinitely from one to three miles. Many of these in the city and vicinity are still held by heirs of the original proprietors, and in most they seemed harnessed only with "hold-backs," refusing to sell their lands at any price or to allow improvements to be made in the shape of new streets, etc., when they can avoid it. One estate we have in special mind near Woodward Avenue, scarcely intersected by streets, thus separating built up portions of the city, and when built upon at all, covered by unsightly tenement houses erected on leased land and inhabited by an undesirable population, and this too in proximity to one of Detroit's finest avenues.

Much to the future good of Detroit be it said, this element of the population, a legacy of that French Colonialism which has always proved retrograde in this country, is fast dying out. A few first-class funerals at this time, we feel sure, would bring to the front quite a different class of controlling minds who could see and would put into action that line of policy which would restore and maintain for Detroit that position among the cities of the Lakes due to her geographical position and great wealth. In the past, municipal fogyism has not entirely dulled her sense—she has felt the beat of the great commerce which the artery of the lakes pulses to her doors—she has grown rich, built strong and well, and manufactures, smelting works, and shipping, line her shores.

Detroit is eminently a manufacturing city, but has no well defined commercial centre. In various parts of the city are aggregated a few blocks of stores, apparently for local trade, and these minor centres are separated by long reaches of residences.

In former days nearly all East and West commerce passed through her doors, and she thought her railway system a model. Slowly the Southern lines under different management, and cursed with no ferry monopoly, draws on her through traffic. With wise forethought, in 1870, she determined to build a tunnel for three million dollars. After construction had commenced, at a critical juncture, it was pronounced financially impracticable by her favorite railway President, contrary to the opinion of the Engineer, and Detroit dropped all thought of a tunnel to sleepily watch in the local legislature and in Congress the lobbying for a bridge that would help to break the weak back of lake commerce and bring its burden to swell the traffic of the M. C. & Gt. W. R. R.'s. Detroit will always wake up soon enough to kill a bridge project and be sleepily indifferent to the tunnel. To-day a tunnel is offered her, completed to her satisfaction without a single dollar risked in construction, for two and a half million dollars or an annual rental of about two hundred and forty thousand. Her common council politely consider it, meet and resolve, and talk and resolve, concluding no doubt, like most common councils, that as their collective wisdom is not invited to revise the plans and superintend the construction or even to manage the finances, there must be some "nigger in the fence." Public opinion dozes along in an easy happy-go-lucky way waiting for something to turn up.

The impression produced by a visit to Detroit is that she is in a sort of trance or stupor. One of these days, when the Canada Southern perfects her plans, as she is surely doing, and builds her tunnel at Stony Isle, Detroit will wake up and howl, and build a tunnel too, and endeavor to divide a stream which she could so easily have made all her own. She may possibly learn then that some individual owning a ferry transfer and exacting toll from every car that crosses her river, has for years been covering all tunnel projects with a wet blanket.

Our stay at Detroit was too brief to allow of a critical examination of her public works. The forenoon was agreeably passed by in a drive down to Fort Wayne. On the way we stopped at the Copper Smelting Works, of which Detroit has a monopoly; and also at the Detroit Bridge & Iron Works, of which Willard S. Pope is efficient President and Chief Engineer. The Fort is replete in historical tradition and incident as well as suggestive of future history. It is almost stripped of its armament, we believe, in accordance with treaty stipulations, and its visible garrison consisted of three privates and two officers, the latter quietly smoking on the piazza of the officers quarters, whether on or off duty we did not learn. The garrison were not demonstrative while we examined this revetted and casemated structure, which we believe was designed by the now Gen. Abbot of the engineer corps, and is of considerable interest to the young engineer.

In the afternoon we went to Hamtramnck to visit the Water Works, the chief object of interest to the engineer at present. At a future day we hope to describe these works in detail, and will submit only some general observations at present, chiefly illustrative of how things ought not to be done.

About the time of the Chicago fire, Detroit determined to build additional water-works, and partially to guard against such accidents as the burning of our own North Side works, located then nearly four miles from the City Hall on the river bank, nearly opposite the head of Belle Isle. The water is taken from the river through a submerged crib, conducted in a flexible-joint pipe to the settling basin, thence to the pumps which force it under a stand-pipe of 120 feet to the old reservoir near the back part of the city, at an elevation of about 75 feet. This reservoir is quite inadequate, and at the same time is lower than a portion of the city, so that if the present system is continued a supplementary high service will be required, as there is no available site for a high reservoir within reasonable limits. The ultimate remedy will probably be a stand-pipe system similar to that of Chicago. Appreciating such a contingency the Chief Engineer, D. Farrand Henry, has caused a sort of minaret cornice and pinnacle to be placed upon the stand-pipe tower so that ultimately the stand-pipe may be continued to a height of 180 feet. Did the wise common council for a moment surmise the object of this queer architectural device they would undoubtedly have lopped it off as an extravagance and placed the forethought of the engineer in the category of "d—d theoretical ideas."

A few years ago, before the present Engineer was employed, Detroit determined to save the expense of an Engineer of water-works. During that period small-bore wooden pipe was laid on many streets as well as iron pipe of inadequate size. To-day in the event of fire this pipe would be found entirely insufficient. It must also be replaced soon at great expense to make the new works available, and in addition to all, there are no records except a few unintelligible pencil sketches by which the present Engineer can tell the location, kind of pipe, or size laid during that period. We are sorry to say that other cities are imitating the wisdom of Detroit at that period under the plea of a mistaken economy. But to return to our subject, what we have to say only illustrates perhaps what an able Engineer can accomplish against the omniscience of a Board of Public Works.

The works at Hamtramnck are located in a marsh between the road and river. Several hundred feet back from the road is the water works building, a very large and commodious structure with foundations for two sets of machinery. This building has considerable architectural pretensions but reminds one rather of an overgrown dwelling than a special design for water works purposes. It is located on a clay knoll with excellent foundations in solid material. Between the building and the river is the settling basin located in a marsh of unfathomable depth. Long piles were first driven into the soft ooze without, however, encountering a firmer stratum, and these were simply tied back to other piles in the rear without bracing; double sheet piling was driven, the whole enclosing a rectangular area which was subsequently dredged with difficulty to a depth of sixteen feet. When the material was removed the enclosing structure was warped and twisted in a most eccentric style. After straightening the structure as well as possible, the inside piles were driven and an overhanging promenade constructed, entirely surrounding the basin, thus concealing in large measure the defects of the enclosure. The gate houses or chambers at either end of the basin have settled, and will rest probably at angles as mysterious to the future antiquary as the angle of the great pyramid. Across the basin a partition reaches to within a foot of the surface, and the theory is that any material brought in from the river in times of storm or soil through the inlet pipe will be dropped before the diaphragm is crossed. The diver was reported to say that he sank up to his waist in ooze at the bottom of the settling basin. We saw eel grass growing, and a mud turtle basking in its waters. We would advise Detroit to turn the settling basin into an aquarium and thus utilize in some way the hundred and fifty or more thousand spent in its construction. Of course we have not examined the subject critically, but it seems to us that the settling basin, if necessary at all, might better have been located, either to the south of the building or between it and the road, or even on the site of the building itself, that structure being placed nearer the road, thus enabling the basin to be constructed in solid material at less expense, and to be of use when completed.

One incident in laying the inlet pipe is of interest. When the cut dredged through the marsh was filled back, a considerable length of pipe rose to the surface on top of the filling. The cut was redredged, and with proper precaution in filling back, the pipe kept its place. The flexible joint was designed by Mr. Henry, and has many points of merit. The submerged crib in various forms has been used at Detroit for a long time. The last design of Mr. Henry is made specially to avoid anchor ice which has always proved an annoyance. The flexible joint, submerged crib, anchor ice, etc., we hope to discuss at a future time.

A coal slip has been excavated for a long distance in from the river to near the building, providing a most excellent and convenient dock.

The engines, now nearly completed, we think would merit the greatest share of criticism from a competent mechanical engineer. They are compound double-beam engines, with double-acting plunger pumps, of 25,000,000 gallons capacity, fitted with old-fashioned toe and rocker valve gear and with an independent air pump. Their appearance was exceedingly clumsy, the cylinders short and very large, the high and low pressure cylinders being set vertically at opposite ends of the beam with very long intermediate passages. We were told by Mr. Edwards, the designer, a local mechanical engineer, that he expected a duty of 60,000,000, and we could easily credit the statement. We also understood that they expect to make no official duty test, which, we trust is a mistake, as we have considerable curiosity as to the result.

However, the citizens of Detroit are to be congratulated on obtaining so good an engine. We were told on reliable authority that the Board were intent on building engines similar to those at the old works, arguing, plausibly enough, that they had always been reliable and had done long and faithful service. By the strenuous opposition of the chief engineer and Mr. Edwards the design for a compound engine as compared with the old engine was submitted to a committee of five local experts, who decided as between the two unanimously in favor of Mr. Edwards' design, the contract for which was forthwith let to a Detroit firm.

We have no criticisms to offer in regard to its construction, as no doubt competent firms exist in Detroit, but we think it a great pity in these days when pumping engines giving a 100,000,000 duty are becoming common, that the design was not thrown open to com-

petition as well also as the construction. We believe that Detroit in not thus throwing open both design and construction to legitimate competition, has stood most seriously in her own light; but we doubt if enough engineers could be convened to convince her common council of her error.

We called at the office of the city engineer, H. D. Ludden, but did not find him in. Detroit is tunnelling a seven-foot sewer back from the river under the city at a depth of fifty feet. We understand that the operations are of much interest and that the sewer system as laid out possesses many points of merit, but we were not afforded the opportunity of making an examination. After all it is much easier to criticise than to commend judiciously. The conservatism of Detroit may make and does make costly errors, but it is not troubled, we believe, with "rings" or wild expenditures on visionary projects or schemes of doubtful improvements.

Her expenditures are watched closely if not always wisely, and the citizens can complain of no heavy debt or taxation. Could the same spirit of economy be combined with wisdom Detroit would be truly wise as well as beautiful.

During our stay we called upon Capt. Adams, in charge of the Lake survey, during Maj. Comstock's absence in Europe. The lake survey will be essentially completed this year and the results published in 52 charts. Then it is expected that the force will be transferred to the Lower Mississippi to execute the surveys contemplated by the works recommended by the Levee Commission.

In the evening we left by boat for Cleveland, where we hope to find less to criticise and more to commend, or else ourselves to be in a less bucolic mood. We do not mean by this that we found nothing to commend in Detroit, for we saw much, but we learn most by other people's failures. If we have spoken unadvisedly we hope some of the good people of Detroit will correct us. Dx.

LIVERPOOL ENGINEERING SOCIETY.

The usual fortnightly meeting of this Society was held on Wednesday evening Oct. 10, at the Royal Institution, Colquilt street, Liverpool. The president, Mr. C. Graham Smith, A. I. C. E., in the chair. After the ordinary business had been disposed of, Mr. I. E. Clanchy, late sub-resident engineer first section San Paulo and Rio de Janeiro railway, read a paper on "Railway Engineering in Brazil." Attention was called at the outset to the great want of means of inland communication in Brazil. The area of the country is about 3¼ million square miles, and it has only 1200 miles of railways completed and about 500 miles more contemplated, and even this cannot be fully utilized owing to the want of good roads into the interior. Existing roads such as they are, were described as mere bridle paths tracked out hap-hazard, seldom repaired, and in no way protected from the action of floods in the rainy season. Under these circumstances horses and pack mules are the safest and most expeditious means of journeying in the Brazils. Mr. Clanchy expressed an opinion that the question of good roads was of paramount importance in the future progress of Brazil, because at present their absence was a check to railway extension. The earlier lines in Brazil were constructed to the Irish (5 feet 3 inch) gauge, but the later ones to the metre gauge, and now both systems are in progress,—the broad guage trunk lines having to construct their main line extensions on that system, while the branch lines generally undertaken by independent companies, have adopted the narrow gauge. The author next proceeded to describe the railroad (single line, metre gauge) with which he was connected, and the difficulties they had to encounter both in the preliminary exploration of the country and subsequent construction of the line. Generally there was neither map nor road to follow, and sometimes forests to pierce in which it was impossible to advance a yard without cutting a path through the matted undergrowth. A graphic description was given of the manner in which a survey line was run through such a forest. Peasants were employed to cut a picada or narrow path under the direction of one engineer while another followed with the theodolite. Under such conditions extreme care was required in setting up the instrument, as with the frequent changes required, there was increased liability to error. The instruments used were Adie's and Elliott's 5 inch theodolites without vertical circles and reading to 30 seconds. The work of construction was let to contractors at a fixed schedule of prices, each contractor taking a certain length of line. The author paid a tribute of praise to the better class of these men, but the general run were a nondescript set who cared little and knew less about their work. Details were given of the average prices for various kinds of work materials, and the slopes adopted in the cuttings. The rainfall sometimes being 30 inches in 24 hours necessitated large provision for drainage, brick culverts being used for the purpose. Stone is in some parts scarce and foreign masons have to be employed to dress it, but clay is plentiful and the natives are skillful in brick-making. Mortar was the great difficulty, limestone being so scarce that oyster shells had to be used to make lime; and cement has to be imported from England at a cost of £3 per barrel. Iron was used for all bridges and is now being used for sleepers, timber being too perishable in a tropical climate. On conclusion the author stated that the cost of the line varied from £1,200 per mile over level ground, to £4,000 per mile where the earthworks were unusually heavy, and on one section including a tunnel 200 metres long, and a bridge 500 metres long, it reached £11,500 per mile, which compares favorably with other existing structures of a similar nature.

W. Wilkinson Squire,
Dock Yard, Liverpool.

THE METRIC SYSTEM.

At the last meeting of the Boston Society of Civil Engineers (held Oct. 17th 1877), it was voted to send the following Memorial to Congress.

To the Honorable the Senate and House of Representatives of the United States in Congress assembled:

The memorial of the Boston Society of Civil Engineers respectfully showeth: That the incongruous weights and measures which have been in general use by this Nation since its birth, are inconvenient in computation, ambiguously named and irregular in their ratios to one another; whereas the Metric System which was legalized in the United States in 1866 and has been adopted by nearly all the governments of Europe and America, has decimal subdivision, like the federal coinage, a uniform nomenclature, and very simple relations between its several units.

The following named seventeen organizations have assured your memorialist of their co-operation in petitioning your honorable body to make the metric standards the only legal standards, after some date to be fixed several years in advance, viz.:

Boston Society of Medical Sciences.
Boston Society of Medical Observation.
The Belles Lettres Society of the Illinois Wesleyan University. Bloomington, Ill.
St. Joseph Medical Association, St. Joseph, Mo.
St. Louis Medico-Chirurgical Society.
New England Association of Gas Engineers.
Boston Homœopathic Medical Society.
Engineers Club of St. Louis.
San Francisco Microscopical Society.
Middlesex Mechanics Association, Lowell, Mass.
St. Louis Medical Society.
Alameda County Medical Association, Oakland, California.
Chamber of Commerce, Richmond, Virginia.
Mt. St Mary's Seminary of the West, Cincinnati, O.
New Haven Medical Association.
Massachusetts Medical society.

That the following resolution was proposed in the 44th Congress, as appears from the Congressional Record for May 8, 1876, but was never voted upon:

Resolved, that the heads of the Executive Department of the Government be, and they are hereby requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures whose use has been authorized in the United States by act of Congress; and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States.

Your memorialist therefore prays for the adoption by your honorable body of the said proposed resolution.

The obelisk ship Cleopatra will remain at Ferrol all winter, pending the determination of salvage, the owners of the steamer which recovered the caisson having refused the contractor's offer.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The next meeting of the Club will be held at the Sherman House Club Rooms, Tuesday, November 6th, beginning at 4.00 P. M. Two papers will be presented. By E. L. Corthell, "Some Memoranda of the South Pass Jetties; by L. M. Johnson, "Maintenance of Way." L. P. Morehouse, *Secretary*.

STREET TRAMWAYS*

BY ROBINSON SOUTTAR.

Part 1.—Tramway Construction.

Foundation.—Where a tramway is likely to be subjected to heavy traffic, it will generally be desirable to excavate about 7 inches under the lower surface of the longitudinal sleeper, and to lay a bed of Portland cement or bitumious concrete over the whole width of the tramway. Some doubt has been expressed as to the value of cement concrete as a tramway base, from the fact that in many cases where tramways have been taken up, the concrete is found to have perished; but this is probably owing not so much to the vibration of the tramway as to the poverty of the concrete in the first instance. Tramways have frequently (from causes beyond the engineer's control) to be hurried to completion, and the concrete is attacked by paving beaters and street traffic before it has thoroughly consolidated. A bed of concrete 7 inches thick requires from two to three weeks to set throughout, whereas it is afforded sometimes hardly as many days. When it is necessary to hurry the work, it would mostly be wiser to use bituminous concrete, and this concrete will also be more suitable where the thickness is less than 6 inches.

Cross sleepers should be imbedded in the concrete, as they are of great value in preserving the level of the rails. The rails of the Birkenhead street railway, laid twelve years ago with cross sleepers, preserve their level better than some lines laid at a comparatively recent date without. Objections have, however, been urged against the use of cross-sleepers on tramways, [illegible] said that they injure the concrete by their vibration, and that the paving setts will not bed firmly over them. This is true, to some extent, of rectangular cross sleepers, but the objections will be overcome if cross sleepers with slightly bevelled sides are used, measuring, say, 5 inches on the top and 7 inches on the underside. The concrete cannot fall away from bevelled sleepers, and if they are soundly bedded, and the concrete well punned round them, vibration would appear to be impossible. This being so, the paving will bed perfectly if care is exercised in selecting stone of a depth that will allow of a thin cushion of sand lying between the stone and the wood, and especially if the paving joints are grouted with pitch.

Longitudinal Bearing.—Tramways with rigid iron bearings have been constructed, and mention will be made of these hereafter. It is generally conceded, however, that a continuous timber bearing is an essential element in a perfect tramway. It forms a cushion which absorbs some of the sound and jarring, and renders tramway travelling agreeable and noiseless. It is also of service to the rail, doubtless increasing its life considerably as compared with what that would be if the rail was fixed on an iron bed. It is likely, too, that the elasticity of the timber bearing neutralises in some measure the vibration and hammering to which a tram rail is subject, and which but for the presence of this elastic medium would injure the concrete.

With regard to the life of the timber great misapprehension exists. The Author has taken up pitch pine, spruce, and memel, after it has lain five, six, and eight years, and found it to all appearance as good as when laid. He has also taken up timber which has been lying twelve years, and found it, where the line had been paved, in very fair condition. The timber referred to had carried a rail spiked through the groove, and the timber was in good condition only where it had not been injured by spikes or transverse saw cuts. In constructing tramways a pernicious practice still prevails of sawing the timber and driving wedges into the saw cuts so as to bend it round curves. When this is done the timber splits and rots quickly. Where the curve is so sharp that the longitudinal cannot be sprung

*From Proceedings of the Institution of Civil Engineers, London.

round it, the timber should be sawn to template. If care is taken in these respects, the longitudinal will last fifteen to twenty years, even with the spiked rail. If the box rail (*i. e.*, a rail having side flanges and fastened on the sides with wrought-iron dogs) is used, there will hardly be a limit to the life of the timber. As a matter of fact, however, it will be advisable to change the bearing when the rail is chapged, as the timber will get torn in the operation, and the price of the longitudinal being insignificant, it will be better to have a fresh one with the fresh rail. If, therefore, the rail is calculated to last twenty-five years, the timber, if sound, intact and properly creosoted, may be depended on to bear it as long.

Rail and Fastener.—When tramways were inaugurated in England by the laying of the Birkenhead street railway, the American section of rail was used. Being unsatisfactory, however, it was removed, and a grooved rail, spiked through the groove, substituted. The grooved rail has been laid on every subsequent system, although alterations have been made on the underside and in the manner of fastening the rail. The spiked rail, as laid on the Birkenhead and other tramways has certain advantages. It can be taken off and changed when worn out without the paving being in any way disturbed. The plate-laying is done very readily, and the rails can be be cut and scarfed with great ease. Where, therefore, cheapness at first is the chief consideration, a tramway laid with flat spiked rails will answer; but these have many disadvantages which render them unsuitable where there is much car or street traffic to contend with. The spiking is the weakest point. At first it was feared that the timber would not grip the spikes, and they were made in some instances to go right through and be screwed up with nut and flanged washer beneath. This was speedily found to be superfluous, as the spike-head wore away first. The spike-heads are worn off by the working of the rail, or are knocked off by the car, so quickly that this form of rail requires respiking once a year, or more frequently where the traffic is considerable. The spike-holes weaken the rail, and the spikes acts as wedges, so that the rail is split in a few years; a rail ¾ inch thick under the groove lasting six years and upwards.

The spike rail has been superseded by the box rail. This has flanges on the underside, punched with holes 18 inches apart, alternately on the right and on the left. Through each hole one end of a stout clip is driven, the other end, which is jagged, being driven into the longitudinal sleeper. This rail answers well. The groove is no longer weakened by the fastener, neither is the fastener in any danger of getting injured or worn. Care must be taken to check the sleeper so that it will exactly fit the rail, to press the sleeper well home into the rail by hand-screws, and to see that the fastener is not cracked at the neck in driving. If these points are attended to, a rail fastened in this way will never work loose. These clip fasteners, however, if applied to the ordinary form of rail, by projecting keep the stone immediately adjacent away from the rail, and as they occur very frequently, there being ordinarily fourteen thousand fasteners per mile of double way, the evil is a substantial one. It is found, besides, that every wheel which strikes a hole helps to extend it, until by degrees an interstice is formed along the side of the rail, down which water soaks, washing the bedding from under the stone, and permitting it to sink beneath the rail-level. Anything therefore which prevents the stone from coming dead up to the rail is highly objectionable.

The Author has introduced a rail which seems to meet this difficulty. The flanges are brought in beneath, ⅜ inch, that is, the thickness of the clips; and if a bit of the longitudinal sleeper is gouged out where the hole in the flange of the rail comes, the fastener can be driven in flush with the sleeper and the side of the rail. The paving setts can then be got dead up to the rail, which will thus be firmly gripped, and the tendency to form ruts alongside, which this fastener, excellent in every other respect encourages, is abolished. Not only so, but whereas there has been heretofore an inducement to keep the fasteners widely apart, so as to diminish the number of these holes in the paving, there is now no such inducement, and the number of fasteners can be increased to any extent without the introduction of a single disadvantageous feature.

The changing of tram rails when worn out is such an expensive matter, and a few pounds per yard is of so little consequence in first cost, that it is always better, whether the traffic to be sustained will be little or much, to lay a good stout rail at the outset. The first tramway rails laid in this country weighed rather more than 40 pounds per yard; but the weight has been increased, and 60 pounds is now considered the best weight for rails where the traffic will be great. At present prices it will be more economical to use Bessemer steel instead of iron for the rails. In Liverpool it is proposed to use a rail having a centre groove. Whether experience will justify this departure from precedent remains to be seen. It is to be feared that the friction will be greater, owing to there being no escape for mud and gravel; that the tendency of cars to run off on curves will be greater, and that the centre flanges on the car wheels will be weaker, and more liable to chip off than the side flanges.

Paving.—The paving of a tramway is a most expensive item, amounting to about one-half the entire cost; but it is impossible to avoid this expense. The stone abutting against the rail supports and protects it, and without it the rail would be shaken loose, forced out of gauge, and hammered to pieces by the ordinary street traffic. The attempt has been made to provide this protection economically, by placing a row of setts on each side of a rail, and filling between with macadam. It is, however, impossible to maintain the narrow strips of macadam at the same level as the setts, and the road soon gets into a rough state. The inconvenience to the public is equalled by the inconvenience to the tramway company, whose horses, running upon the uneven road with one foot on stone the other on macadam, will stumble and fall lame daily. On this point engines would have the advantage over horses. Asphalt has been tried as a pavement for tramways, but has proved a complete failure, and has in most instances been replaced by stone. Superficially speaking, it would appear to have advantages. It can be laid with neatness and uniformity from rail to rail, and makes at first a very close joint with the rail. The slight vibration to which a tram rail is subject soon frees it from the asphalt, which then exposes alongside each rail two edges, and as asphalt seems to be specially weak at its edges, it is soon ground into holes and ruts. So far as wooden pavement has been tried it has scarcely given more satisfaction. The wear along the rail side is so great that nothing but hard stone will support it. If any other material is used it should be looked upon as an expensive luxury, and the cost of repair should be borne by those for whose benefit the luxury has been provided. Looked at in this light, the Improved Wood Pavement Company's system is probably the only one at all suitable, as the longitudinal sleeper could be fastened to the boarding in a way which would keep the setts and rail at one level until the former were fairly rubbed away. Where the gradient of the street renders hard stone unsuitable for the traffic, it will sometimes be best to let the rows of setts immediately abutting on the rail be of a hard nature, and to pave between with a less slippery stone. The joints of the paving should be racked with dried shingles and grouted with pitch. This impervious pavement is of special value on a tramway, as the rain-water flows down the rail, and (unless the joints are sealed by pitch) sinks down by the rail side, causing the setts to present a ragged appearance, and washing away racking and bedding. Excessive ramming should not be permitted where the tramway has been well concreted, as the concrete will be greatly injured. It will be necessary to tap the stones lightly with the rammer, so as to shake the shingle into the joints, but nothing beyond this should be allowed. The stones alongside rails should be picked, care being taken to see that they can come dead up to the rail, that they are exactly the depth from rail to concrete, so that they may never sink beneath the level of the rail, and that they break joint well with one another.

Points.—Points were at first made wholly of cast iron, flat, about 6 feet long, and spiked through the groove. Soon side flanges were introduced, and gradually it has been found desirable to lengthen the point, so as to make it easier, until 9 feet has come to be the favorite length where the rail is 4 inches wide. The points wear rapidly at the end of the tongue, where the wheel of the car bears only upon a small portion of the tread. Under heavy traffic a point will wear greatly in this place in twelve months; but the point will not thereby become unworkable, and where appearance is not much object it will last two years. Chilled iron gives somewhat better results, but there is not much difference. A good plan is to insert two pieces of cast steel, one in the tread and one in the tongue. These are securely riveted to the cast iron, which has a recess for the steel, and a projection, which, serving as a back, prevents the steel from being knocked out of position. A point so constructed should last three years. The same idea may be ingeniously varied, by making the steel in one piece, bevelled in front and secured by a pin behind, so that it may be taken away when worn out and replaced by a new piece, without the point being disturbed. This last is probably the best point yet designed. In movable points the tongue should be made of one piece of steel, and not of steel and iron welded together.

Crossings.—Crossings were at first made flat and spiked in the grooves. They were found to wear out and snap across quickly. They were then cast with side flanges, and in this form they wear better, but are still unreliable. Besides, curves in tramway work are so various, and sometimes of necessity so sharp, that it is far from easy to keep a stock of crossings in hand sufficient to maintain an existing tramway, and very troublesome to model with sufficient accuracy patterns for a new one. Consequently, where cast-iron crossings are used, curves have frequently a broken-backed appearence. It is better to lay the rails throughout with all necessary curves, and then, having marked the places where the rails cross, cut or saw them with the proper bevel. In laying crossings the longitudinal timber and rails should be made to break joint, the scarfed timber being bridged by a continuous rail, and the scarfed rail lying on a continuous timber.

Curves.—The question of curves is still misunderstood in tramway work. It having been found that cars can be hauled round almost any curve, little care is taken to lay easy curves. This is a great mistake. On a sharp curve the cars will get wrenched, the horses strained, and the passengers occasionally injured. Where there is any choice the curves should not be sharper than from 150 to 200 feet radius. The Author was surprised to see plans for an important system of tramways where it was proposed to construct passing places with curves of 60 feet radius, and room for one car only; whereas all experience shows that passing places should have room for two cars at least. Cast-iron rails have been used for sharp curves, but they wear and break quickly. Flat rails are also used, the idea being to let the wheels take their natural course, one slightly outside the other. But on very sharp curves, where flat rails would appear to be most necessary, they, having no groove wherewith to catch the flange of the wheel, permit it to leave the rails. On sharp curves, where cars had the habit of running off, the Author has frequently had to take up flat rails and lay grooved rails. The proper course would be to roll rails with greater grooves for use on curves; but this would be expensive, and unnecessary. Wrought-iron rails can be bent to any curve over 30 feet radius by the "Jim Crow." Steel rails had better be at least partially bent at the rolling mill.

Single Line.—Single line may be loop line, whereby the up car traverses one street the down car another, or single line with passing places. Where the streets traversed by loop lines are more than a trifling distance apart loop lines are most objectionable, as it is found that though the through traffic from the point where the lines diverge to the place where they again meet is secured, the local trafic along either single line remains undeveloped. If residents can only depend on a car one way, they will not depend on the car at all. It is easier to develop local traffic upon a single line with passing places, than upon a loop line; nevertheless the former still labours under grave disadvantages. The ideal tram car will glide along swiftly and noiselessly, a constant temptation to the foot passenger. On a double line this may be, but on a single there is inevitably so much delay that the cars, instead of being a temptation, will occasionally be a source of ridicule to the foot passenger. It is also hard to keep single lines in repair. Compared with double lines a single line will not wear half so long, and the passing places, with their points, crossings, and curves, are expensive to maintain, and a nuisance in the road. Excepting under peculiar circumstances, for instance, where the line

is intended for goods, or where only cars at great intervals are proposed to be run, it is generally unwise to lay a single line if the street is wide enough for two lines. Where cars run frequently, the greater revenue and the lesser wear and tear of roads, cars, and horses, quite counterbalance the interest on extra capital. Where, however single lines are necessary the passing places should be numerous, lengthy, and with easy curves.

There is an art in laying the points of passing places of great importance. Generally a main line is run through the centre of the road, and the passing places are laid on one side, the points being arranged so that the cars will run forward in the straight line, unless dragged over into the passing place, or the lines are in similar positions on opposite sides of the road, and the points equally divided, so that the cars have to be pulled across into either road. Now, as by the rule of the road vehicles should always pass by the left, it is evident that if the points are cast straight on the left hand, and that straight groove is laid exactly in the line of the rail immediately preceding the passing place, the car will run, without the horses being required to use any effort whatever, along its proper road. The advantage is evident. Cars no longer miss the points, and pushing back, and confusion, so irritating to the passengers and injurious to the popularity of tramways, are avoided, as well as much of the delay hitherto considered incidental to single lines. Collisions with cars and other vehicles, caused by the car getting on its wrong side, are minimised, and there being no longer any need for straining, the saving in horse-flesh is great The same system is applicable to cross-overs and by carrying it out thoroughly, movable points and pointsmen can frequently be dispensed with.

Suitable Roads for Tramways.—Tramways have practically conquered the fierce opposition that was directed against them some time back in this country; but they are still regarded as an inconvenience by owners of private vehicles, and there can be no doubt that they always will to some extent injure the surfaces of the streets through which they are laid. This is particularly true in streets where the breastwork beyond the 18 inches of paving prescribed for the tramway is macadam owing to the difficulty experienced in keeping macadam and stone in a uniform level. It is better when a tramway is laid to pave from rail to channel; and if the paving along the centre width of the street, as well as the formation of the concrete bed beneath, can be carried out simultaneously with the construction of the tramways (sufficient care being taken with the manufacture of the concrete and with the selection of the paving setts), a surface should be arrived at which will interfere very little with the ordinary street traffic.

It may be roughly understood that a single line of tramway should not be laid in a street of less width than 24 feet; a double line in less than 32 feet. When it is desirable to lay a tramway in a street of less width, it may be more convenient to keep to one side. The question of gauge does not affect that of street width, as the width of the car is not ruled by the gauge of the line, but by the amount of room required for the convenience of passengers. Tramways will generally be found to facilitate instead of hindering the traffic even in narrow streets, as the cars compel or induce drivers of other vehicles to drive in regular lines.

Iron Tramways.—Though a timber longitudinal is most in favor, still various descriptions of iron bearings hsve been invented, and the question of wood *versus* iron. settled long since in railway construction, has been revived to a certain extent in connection with tramways. In a book written lately on tramway construction the arguments generally used against a timber bearing are stated as follows:—"For tramways, it appears to us worse than useless to provide an elastic bed for the rails; for when the bed of the rails is elastic, and that of the contiguous paving is inelastic, there is an unequal settlement of these two important parts." But it will be evident, especially to those who have had to keep tramways in repair, that in this argument the elasticity of the timber bearing is entirely overestimated. It is not to be imagined for a moment that a sound longitudinal timber will ever be compressed by either street or car traffic, so that the rail will be appreciably lowered. In practice the difficulty is to keep the paving up to the rail, not to keep the rail up to the paving, and where rails are occasionally depressed it is entirely owing to the settlement of the foundation under the sleeper, and never in a single instance to any compression of the timber.

(*To be continued.*)

TURNPIKING AND UNDERDRAINING COMMON ROADS.

BY R. C. CARPENTER, C. E.
Michigan State Agricultural College.

(*Concluded from page 301.*)

PRACTICAL DIRECTIONS.

The following methods of preparing a turnpiked road are followed by different road makers. It may be advisable in many cases not to employ any one method to the exclusion of the others, but to employ a combination of the methods, or one a portion of the time, and the other the remainder:

First method (employed by Prof. A. B. Gulley in building the Detroit and Saline gravel road).—This requires one teamster and one or two men to handle the scraper, the number depending on its weight. On the side of the roadbed and parallel to it, plow just the number of furrows that will give a good scraper load when the scraper is drawn square across the road. Two or three furrows will be sufficient; if too many are plowed the scraper will not do clean work. Scrape these upon the roadbed by driving square across the road to the centre, then back to the place of loading, having the men pull back the scraper, and the teamster attend to the team alone. Treat the other side of the road in the same manner. Then plow again on the first side outside of the first furrows and scrape as before. Proceed in this manner until the road has been brought to the required form, finishing up the side channels as directed.

Second method.—This differs from the first in no essential manner except in driving from one side of the road to the other, taking loads alternately from each side of the road and leaving them as before described. The labor required in handling the scraper will be less than in the first method.

Third method.—The third way of constructing a turnpike road is to first plow the sod on the side of the road the width of the ditches, which should not be less than 10½ feet for a roadbed 24 feet wide; second, scrape the turf or sod upon the centre of the road, striking the furrows endwise with the scraper and having the team pass around in a circle; third, when the sod the whole width of the ditches is removed to the roadbed, plow again, making the furrows deeper to the centre of the ditches. Scrape this earth upon the roadbed, rounding up the centre and filling all the inequalities caused by the sod; fourth, drive lengthwise of the ditch with the scraper and remove all obstructions to the continuous flow of water. One man only is required by this method, the manual labor is considerably lessened as compared with the other methods, though the team work is increased. The relative cost of the different methods will depend upon the relative cost of hand and team labor, and upon the skill of the workmen. It is generally thought that under most circumstances the third method costs somewhat more, but as the sods (if there are any) are all placed at the bottom by this method, it gives a more uniform and somewhat better road than either of the other methods.

The following table is computed on the supposition that all the earth required in forming the road-bed is derived from the side ditches. The slope of the side of the road-bed, from bottom of ditch to the centre, is little more than one inch per foot, and the slope of the outside of the ditches is four inches per foot.

Width of Road Bed.	Depth of Ditch in Inches.		Horizontal Distance in Feet.		Cubic Yards per Rod.
	Below original surface of ground.	Below centre of road.	From centre of Road to bottom of Ditch.	From Bottom of Ditch to Outside.	
36	17.50	31.49	10.94	4.37	13.64
32	15.50	28.63	9.69	3.87	10.71
30	14.50	26.76	9.06	3.62	9.37
28	13.50	24.89	8.44	3.37	8.12
26	12.50	23.02	7.81	3.12	6.96
25	12.00	22.08	7.50	3.00	6.42
24	11.50	21.15	7.19	2.87	5.89
22	10.50	19.28	6.56	2.62	4.91
20	9.50	17.41	5.94	2.37	4.02
18	8.50	15.52	5.31	2.12	3.22
16	7.50	13.64	4.69	1.87	2.51
14	6.50	11.75	4.06	1.62	1.88
12	5.50	9.87	3.44	1.37	1.35
10	4.50	7.99	2.81	1.12	.90
8	3.50	6.11	2.19	.87	.55
6	2.50	4.22	1.56	.62	.28

COST OF TURNPIKED ROADS.

The cost of a road, with the dimensions as given for the road bed 28 feet wide, is estimated by the Chicago Scraper Company to be 25 cents per rod.

Prof. A. B. Gulley, who has had considerable experience in road making, thinks the estimate is not unreasonable with skilled hands, but that it would probably cost from one-fifth to one-half more with the labor usually employed on roads. The actual cost however, will vary greatly with circumstances. Skill in the management and the proper disposition of men will often bring profits to a contractor, when another under the same circumstances, but without this skill and tact, will constantly loose money. Again, it is a well known fact that when work is scarce, even though wages are low, men work much better than when work is plenty and wages are high; indeed it is commonly claimed when laborers are scarce and wages high that they can scarcely be depended on for more than three-fourths of the work they readily accomplish when wages are low and when fresh hands are waiting to be hired in case any are discharged. Again, long spells of either wet or dry weather may make the earth more difficult to move, and add considerable to the cost.

The following table of cost for moving earth is based on a paper by Ellwood Morris, C. E., of Philadelphia, published in the Journal of the Franklin Institute, 1841, which has been extended to cover the cost of moving earth by scrapers. The following basis of calculations was adopted: labor of man one dollar per day; of horse 75 cents per day; of plow 37 cents per day, and of scraper 25 cents per day. The results in our table must therefore be increased or diminished in about the same proportion as common labor costs more or less than this. It is supposed that one man does all the scraping, and keeps his team continually walking in a circle. The radius of this circle will approximately be the distance from the bottom of the ditch to the centre of the road, although the centres of gravity of the space to be filled and the earth to be moved are somewhat nearer.

It is further assumed that seven scraper loads are required to move each yard of earth, which is about the average scraper load for a *good* road scraper. A skilful hand can hold the scraper so as to increase the amount of this load a good deal, but care should be taken that the scraper does not gouge into the ground which has not been loosened by the plow, as it will unnecessarily strain the team and soon tire them out, while it will give no increase to the load; on the contrary it will usually result in the complete or partial emptying of it.

Horses usually walk, before a loaded wagon, two and one half miles per hour for ten hours per day, but walking and constantly turning, the rate will probably be diminished to about one and one-fourth miles per hour, or about one hundred feet per minute.

The cost of loosening the earth with a plow is given by Trautwine as follows:

	cents per yard
Strong heavy soil	1.6
Common loam	0.8
Light sandy soils	0.4
Very stiff pure clay or cemented gravel	2.5

And the cost of spreading for the heavy soils one and one-half cents per yard, and for sandy soils one cent

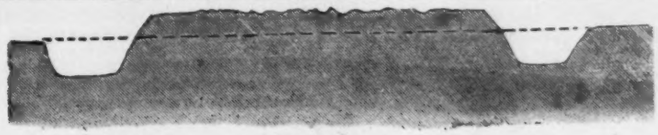


Fig. 1.

Fig. 2.

Fig. 3.

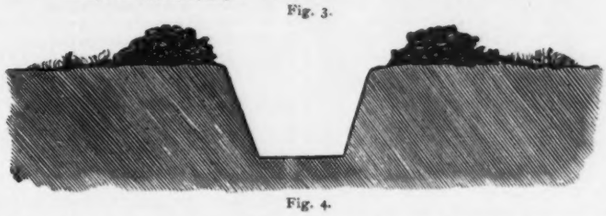


Fig. 4.

per yard, where wagons or carts are used. Since most of the work of speading is done by the scraper, the cost of spreading and leveling can safely be estimated at one-half of one cent per yard. The cost of clearing up and finishing the ditches cannot well be estimated, as it will vary much with different surfaces. For that reason the cost of finishing the ditches is not included in the following table of the cost per rod of turnpiked roads.

Width of road bed in feet.	Distance earth has to be carried in feet.	Distance passed over by team in feet, for each load.	No. of loads per hour, velocity 100 feet per minute.	Yards drawn per day of 8 hours.	No. of cubic yards excavated per rod.	Cost per cubic yd. of scraping, etc.	Total Cost per Yard in Cts.				Total Cost per Rod in Cts.			
							Very stiff Clay	Heavy soil.	Loam.	Sand.	Very stiff Clay.	Heavy soil.	Loam.	Sand.
36	33.3	104.5	57.7	65.94	13.64	4.18	7.18	6.28	5.48	5.08	98.0	85.7	74.8	69.3
32	29.6	93.0	64.5	73.71	10.71	3.74	6.74	5.81	5.04	4.64	72.2	62.5	54.0	49.7
30	27.7	87.0	68.9	78.81	9.37	3.49	6.49	5.59	4.79	4.30	60.8	52.4	44.9	41.1
28	25.8	81.0	74.1	84.68	8.12	3.24	6.24	5.34	4.54	4.14	50.7	43.3	36.9	33.6
26	23.9	75.1	80.0	91.44	6.96	3.00	6.00	5.10	4.30	3.90	41.8	35.5	29.9	27.1
25	23.0	72.3	83.0	94.85	6.42	2.88	5.88	4.98	4.18	3.78	37.8	32.0	26.8	24.3
24	22.0	69.1	87.0	99.44	5.89	2.76	5.76	4.86	4.06	3.66	32.4	28.6	23.9	21.6
22	20.1	63.1	95.0	108.56	4.91	2.52	5.52	4.62	3.82	3.42	27.1	22.7	18.8	16.8
20	18.2	57.2	104.8	119.77	4.02	2.29	5.29	4.39	3.59	3.19	21.2	17.6	14.4	12.8
18	16.4	51.5	116.4	132.99	3.22	2.06	5.06	4.16	3.36	2.9[illegible]	17.0	13.4	10.8	9.5
16	14.5	45.6	131.6	150.38	2.51	1.83	4.83	3.93	3.13	2.73	12.12	9.9	7.9	6.8
14	12.6	39.6	151.5	173.14	1.88	1.60	4.60	3.70	2.90	2.50	8.7	6.9	5.4	4.7
12	10.5	34.7	172.4	197.04	1.35	1.37	4.37	3.47	2.67	2.27	5.90	4.7	3.6	3.1
10	8.9	29.9	208.3	238.19	0.90	1.14	4.14	3.24	2.44	2.04	3.7	2.9	2.2	1.9
8	7.0	22.0	272.7	311.69	0.55	0.91	3.91	3.01	2.21	1.81	2.2	1.6	1.2	1.0
6	5.2	16.1	384.6	439.55	0.28	0.69	3.69	2.79	1.99	1.59	1.0	0.8	0.6	0.5

UNDERDRAINING.

The best possible arrangement for surface drains will not remove all the water from the road, and in many cases other methods of removing the water must be adopted. The best of all methods will doubtless be found by combining a thorough system of underdrainage with that of turnpiking. In all cases the cross section should have the convex form as shown in Fig. No. 2, so as to prevent as much as possible the absorption of water by the surface of the roadbed proper, which though not perfectly impervious to water under any system of construction, it will, when of this shape, convey the greater portion of the water that falls upon it into the side channels. Even when the underdrain is directly beneath the axis of the road, it is not advisable that the water should reach it by soaking down through the graveled portion of the road, which it would render soft and muddy, but it should be, as far as possible conveyed to the side channels, and from thence to the underdrain, thus leaving the track in the centre as dry as possible.

The advocates of underdrainage of roads present three systems which vary in cost and efficiency. Mr. J. Bailey Denton, in the Journal of the Royal Agricultural Society of England for 1857, advocates two two-inch drains beneath the two edges of the road-bed or traveled portion of the road, and consequently about twenty feet apart. The other systems find advocates in Gen. Q. A. Gilmore and in Geo. Waring, and are as follows: 2d, two underdrains, one beneath each ditch formed in turnpiking the road; 3d, one underdrain beneath the axis or centre line of the road.

Denton's system though excellent when carried out with the broken stone covering that he recommended, has few features to recommend it for use on a road where in all probability no covering beside the native soil will be applied. The total cost per rod of such tile drain is reckoned by him at less than one English shilling, where the tile costs 20 shilling (English) per 1,000 feet and labor of excavating costs 3 pence per yard, and laying and treading in 6½ pence per chain of four rods.

The second system, in which a drain is placed directly beneath each ditch, formed in turnpiking, has the advantage of relieving the side ditches of much of their work, thus keeping them more free from water, and the disadvantage of being so far from the centre of the road as to effect but little the water that may be beneath the traveled way.

The third system, in which one drain is placed directly beneath the traveled way, has the advantages of being cheaper than the others, inasmuch as less tile and labor would be required, and of conveying away rapidly the water directly beneath the traveled track, and the disadvantage, if it be one, of effecting but slightly the water that may be in the side channels. Two drains of two-inch tile are recommended in both the other systems, and one of three-inch in this.

The third system, where a single under-drain is placed beneath the axis of a well turnpiked road will provide efficient drainage for all cases that will ordinarily arise, and is the only method that will be considered farther in this article, though in many cases, the others may be preferable. We may add, however, that with a road surface of gravel or broken stone, a very large proportion of the water would be conveyed at once to the open side ditches, and the second system of underdrains would, in such a case, be preferable to the third but with our ordinary roads I am inclined to believe a single drain beneath the centre of the road preferable to two, one under each upper side ditch.

It is not within the province of this article to treat fully of the various methods of underdrainage. The points requiring most attention are the only ones here mentioned. The drain should be not less than three feet deep, and whenever practicable four feet deep. An outlet should be provided in every depression of the road, which outlet must consist of a transverse underdrain or a culvert emptying in a stream, water-course, or reservoir, where the presence of water will not affect the road.

The drain should run from this outlet with a continuous ascent in both ways to the top of the nearest elevations that lie in the line of the road. Here the ends may be stopped and a break of a few feet left in the drain, or it may be continued on uninterrupted to the next depression, where another outlet must be formed, as described.

The tiles should be laid with the closest possible joint, and the joint should be farther protected by a *collar* made on purpose, or by a closely mowed piece of tough turf a few inches square, laid with the grass side towards the tile so as to enclose the joint. The tile should be round in the cross section, so that it may be laid any side up. On no account use *horse shoe* tile, whether with or without a bottom. Where tile cannot be obtained, stone or brush may be used; but the drain formed by them will be inferior to that formed by tile. A stone drain may be formed by making a channel with flat stone, or by putting in small cobble stone promiscuously, to the depth of eight or twelve inches, and covering with straw and earth. Brush drains are made by laying the brush lengthwise the drain, with the small end towards the outlet. I have known stone drains, made as above described, to work well, but I have had no experience with brush drains.

COST OF UNDERDRAINAGE.

The cost of tile at the brick kiln near Lansing is as follows: Two-inch tile costs $12.50 per one thousand pieces; three inch tile costs $16.00 per one thousand pieces, four-inch tile costs $30.00 per one thousand pieces; which would be per rod, for the two-inch tile about 21 cents; for the three-inch tile, about 26 cents; for the four-inch tile, about 50 cents, as each tile is one foot in length. It is commonly estimated that two-inch tile can be made with a good living profit for $11.00 to $11.50 per one thousand, so the rates should not differ much from those at Lansing near any manufactory in the State. Where the cost of transportation is very great, the expense of the tile will be considerably increased. The cost of two-inch tile delivered will be assumed $15.00 per one thousand or 25 cents per rod, which allows $2.50 per one thousand to pay cost of delivery; the cost of three-inch tile delivered will be assumed at $18.00 per one thousand, or 30 cents per rod; of four-inch, delivered, about 55 cents per rod, in the following table.

The cost of digging, with labor at one dollar per day it estimated by Waring to average for drains four feet deep, 29 cents per rod, and for laying and filling 7 cents per rod. At the same rate per yard a drain 3 feet deep would cost for digging 18½ cents per rod, and for filling 4 cents per rod.

Gen. Gilmore gives the cost of cutting and filling a drain two feet deep, with labor at one dollar per day as 15 cents per rod; this, when covered with the earth scraped in from the side channels, would, for a roadbed 25 feet wide, be made nearly three feet deep. Henry F. French estimates the cost of the cutting and filling of a drain four feet deep 33⅓ cents per rod; of a drain three feet deep, 20⅔ cents. The drains should be dry and laid before the turnpiking is done, thus saving the cost of digging through the earth scraped into the centre of the road. The drains can be filled in all cases with the road scraper.

The following table of costs is based on estimates of

French; it might have been extended to cover drains in a variety of soils, as in the preceding table relating to cost of turnpiking, but it was thought that the average would be sufficiently accurate:

TABLE OF DATA FOR UNDERDRAINING ROADS.

Width of Road bed in feet.	Depth below original surface which will give a drain 4 feet deep when turnpike is finished.	Cost per rod for cutting and filling in cents.	Total cost per Rod of Tile Drain, in Cents.			Total Cost per Rod of Turnpiking and Underdraining on heavy soil, in Cents.		
			2-inch tile.	3-inch tile.	4-inch tile.	2-inch tile.	3-inch tile.	4-inch tile.
36	2 feet 10 inches	18.9	43.9	46.9	73.9	129.6	134.6	159.6
32	2 " 11 "	19.8	44.8	49.8	74.8	107.3	112.3	137.3
30	3 "	20.5	45.7	50.7	75.7	93.1	103.1	128.1
28	3 " ½ inch	21.5	46.5	51.5	76.5	89.9	91.9	119.9
26	3 " 1½ inches	22.4	47.4	52.4	77.4	82.9	87.9	112.9
25	3 " 2 "	22.8	47.8	52.8	77.8	79.8	84.8	109.8
24	3 " 2½ "	23.2	48.2	53.2	78.2	76.8	81.8	106.8
22	3 " 3 "	24.1	49.1	54.1	79.1	71.8	76.8	101.8
20	3 " 4 "	25.0	50.0	55.0	80.0	67.6	72.6	97.6
18	3 " 5 "	25.9	50.9	55.9	80.9	64.3	69.3	94.3
16	3 " 6 "	26.7	51.7	56.7	81.7	62.6	67.6	92.6
14	3 " 7 "	27.5	52.5	57.5	82.5	59.4	64.4	89.4
0	4 "	33⅓	58.3	63.3	88.3	53.3	63.3	88.3

FALL OF DRAIN.

The fall that is given the drain may be varied considerably; it should not be so great that the water will tend to follow along on the outside of the tile and undermine it, nor so little that the drain will not discharge freely. These limits must be determined to a great extent by the nature of the ground, but in general the extreme limits for ordinary workmen will be from eight feet to three inches fall in 100 feet measured horizontally. It is hardly safe to depend upon a drain laid with slopes greater or less than these extremes, though drains have been laid and performed satisfactory work with a fall of one-tenth of a foot in 1,000 by exercising great care in keeping the fall uniform and the joints tight. In soil difficult to wash it is probable that drains with a slope greater than 8 in 100 or 1 in 12½ could be made and laid so as to retain their positions; but in moist soils it would not be advisable to try a slope even as steep as 8 feet in 100. The surface of the road should never rise more than one foot in going 25 horizontally, so there will be no need of caution for getting drains too steep; but in some cases it may happen that a sufficient fall can only be obtained by making the outlet deeper than the end of the tile. Suppose the road lie across a level marsh one mile in width as an extreme case; suppose farther that outlets can be provided in but six places and are one-sixth of a mile apart, the two outer of which are one-twelfth of a mile from the edge of the marsh; this will require each drain to be one-twelfth of a mile long; if the outlet be made four and one-tenth feet deep and the extremity three feet deep, a fall of three inches in 100 feet will be secured and the water of the subsoil will be conveyed rapidly away. In such a case as this the outlets will be very expensive. They should consist of ditches with a sufficient capacity to convey the water rapidly away from the mouths of the tile and also from the open side ditches. The case in which outlets could not be provided has already been discussed under the head of turnpiked roads, and will need no further discussion here, as underdrains could possibly do no good.

BOOKS OF REFERENCE.

If detailed instructions in the formation of underdrains are needed, the reader is referred to Draining for Profit and Health, by Geo. Waring, and to French's Farm Drainage, both of which works are for sale at the office of ENGINEERING NEWS. In the Report of the Michigan State Board of Agriculture for 1873 there is an article, well illustrated, by Prof. M. Miles, entitled Improvements in Tile Laying, which is well worth careful study.

THE following information relative to Harbor Improvements is taken from the advance proof sheets of the Chief of Engineers' Report, together with the estimates and recommendations of the officer in charge:

Officers in charge, Maj. G. L. Gillespie, Corps of Engineers, to May 5, 1877, since which time Capt. G. J. Lydecker, Corps of Engineers.

Chicago Harbor, Illinois.—Three courses of superstructure, with stone-filling and planking, were built on the north pier extension, 600 feet in length; twenty-four oak piles driven and capped as a protection to the pier-head. The close pile protection on seaside or breakwater was extended 292 feet. Some of the breakwater cribs were partly refilled with stone, to provide against settlement which has taken place since their completion in 1875.

The unexpended balance available at the close of the year will be applied to repairing the old piers and extending pile protection at end of north pier.

An appropriation of $150,000 is recommended by the officer in charge for the fiscal year ending June 30, 1879, to be applied as follows: $100,000 for continuation of breakwater; $40,000 for dredging in outer harbor; $10,000 for repairs of old piers.

July 1, 1876, amount available		$ 15,524.92
Amount appropriated by act approved Aug. 14, 1876		5,000 00
		$20,524.92
July 1, 1877, amount expended during fiscal year		17,855.48
July 1, 1877, amount available		$ 2,669.44
Amount that can be profitably expended in fiscal year ending June 30, 1879		$150,000.00

Calumet Harbor, Illinois.—Work at this harbor was not commenced during the fiscal year until the 1st of May; since then 13,866 cubic yards have been dredged between the piers and through the outer bar.

Materials for extending the North Pier 150 feet have been purchased, and the work of framing cribs commenced. Dredging operations will soon be suspended, when about 18,000 cubic yards will have been excavated. The extension of the North Pier will exhaust the balance of the appropriation.

The original estimate of this improvement was, in round numbers $300,000 of which $250,000 has been appropriated to date, leaving $50,000 to complete, all of which is asked by the officer in charge for the fiscal year ending June 30, 1879. This is needed to complete the dredging and to extend the piers into deep water.

July 1, 1876, amount available	$ 1,807.33	
Amount appropriated by act approved Aug. 14, 1876	20,000.00	
		$21,087.33
July 1, 1877, amount expended during fiscal year	$ 6,648.29	
July 1, 1877, outstanding liabilities	2,30,.80	
		8,956.09
July 1, 1877, amount available		$12,851.24
Amount (estimated) required for completion of existing project		$50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1879		50,000.00

Michigan City Harbor, Indiana.—The principal work contemplated at the beginning of the year was to place the superstructure on twelve cribs of the breakwater, which was sunk during the previous season. No money became available for this purpose until the middle of September, and it was the 1st of October before the work was fairly commenced. The season was then so far advanced that it was almost impossible to make much progress, the work at the beginning being from one to three feet under water. By the end of November there was one course of the superstructure above the water over the entire length of the breakwater except one crib, and the second course was placed for a distance of 200 feet; the entire work was well filled with stone. A terrible gale lasting four days (Nov. 28 to Dec. 1) destroyed all that had been accomplished, and the severity of the weather precluded any further operations at that time. Work was resumed May 1, and continued until the end of the year in repairing the damage done to the unfinished work by the gale referred to, and by subsequent storms during the winter. The bulk of the last appropriation has been exhausted in this way. The experience of the past year at this exposed point indicates the urgent need of making the next appropriation sufficient to complete the work, at least as far as necessary to avoid damage and loss such as that above reported. The amount required for this purpose is $100,000, to be applied as follows:

For completing construction of Breakwater		$ 75,000.00
For re-filling and repairing harbor piers		5,000.00
For dredging in outer harbor		20,000.00
July 1, 1877, amount available	$ 1,191.05	
Amount appropriated by act approved Aug. 14, 1876	35,000.00	
		$ 36,191.05
July 1, 1877, amount expended during fiscal year	$ 25,579.12	
July 1, 1877, outstanding liabilities	1,621.82	
		$ 27,200.94
July 1, 1877, amount available		$ 8,990.11
Amount (estimated) required for completion of existing project		$120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1879		100,000.00

New Buffalo Harbor, Michigan.—There was no work done here during the year. None is contemplated for the ensuing year.

There has been no appropriation for this improvement since 1872 and none is now recommended.

July 1, 1876, amount available		$ 5,541.85
July 1, 1877, amount expended during fiscal year		528.41
July 1, 1877, amount available		$5,013.44

BOOK NOTICE.

ELEMENTS OF THE METHOD OF LEAST SQUARES. By Mansfield Merriman, Ph.D. London and New York: MacMillan & Co. 1877.

This little volume, although published in England, is from the pen of the Instructor in Civil Engineering in the Sheffield Scientific School at New Haven. The author has divided it into two parts, the first of which clearly sets forth the process to be employed and the steps to be taken in adjusting such observations as the engineer is called upon to make. He is here shown how to ascertain the most probable length of a base line as properly deduced from varying measurements, the value of an angle which has been repeated with instruments of more or less precision, the adjustment of discordant levels between different objects, the reduction of angles in one triangle or more so that their sum shall equal the proper amount, and, in short, to find in any case, those values of data which shall involve the least error.

Even the casual reader, in glancing over the first part, and noticing the character and great number of the examples which are there given, cannot fail to be struck with the value which such a book must possess for the working engineer. The formulæ are taken for granted in this part, and the method of application is most carefully explained so as to be readily apprehended while the mathematical proof of these formulæ is grouped by itself in the second part.

One example discussed is as follows: A quadrilateral is to be determined by the measurement of one side as a base and nine of the angles formed by the sides and the two diagonals. In each of the four triangles which make up the figure the sum of the measured angles differs slightly from 180°, and the sum of the four quadrilateral angles is not 360°. The problem is to adjust these angles so that, in every triangle, the sum of the three angles shall be exactly 180°; so that at every corner the large angle shall equal the sum of the two small ones; so that the sum of the four quadrilateral angles shall be exactly 360°; and further, so that the adjusted values shall differ from the measured values by the least possible amounts. Any engineer will realize the difficulty of making such an adjustment by guess. If it be also required that any side, as calculated from any of the triangles, shall always have the same value, the problem is also attacked and readily solved by the method of least squares. That the U. S. Coast Survey arrive at their admirable results by this means would be a sufficient endorsement of the process to the novice.

Some mathematicians may object to the presentation of the application of the formulæ before their abstract derivation is shown, but many to whom the book will be of service would otherwise lay the book aside, while now they will be enticed, by the very practical treatment of the first part, to look carefully into the dis-

cussions of the second. The various advances from the simpler to the more complex cases necessitate more repetition than a descent from a general to a simpler formula would require, but the author in his experience as a teacher, has probably found that a certain amount of repetition, line upon line, is not a waste of time with the average learner.

Papers by Mr. Merriman in recent numbers of the *Journal of the Franklin Institute*, one on a demonstration of the Method of Least Squares, and the other on its application to an hydraulic problem, viz., the discovery of the equation of the velocity curve in any vertical section of the Mississippi river, as compared with the method by trial, as used by Humphreys and Abbot, have served to call the attention of American readers anew to this subject.

We can cordially commend this little volume of two hundred pages as likely to be serviceable to the profession. The type and execution of the book is good in spite of what at first appears to be a considerable table of corrections bound at the beginning of the book, and in spite of certain spellings which are not accepted here.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

N. D. MUNSON, Assistant Superintendent of the Chicago, Burlington & Quincy R. R., has been made general manager of the Hannibal & St. Joseph, under the new receivership.

SIDNEY MCWILLIAMS, Receiver, took quiet and peaceable possession of the Hannibal & St. Joe R. R. and all its general offices on the 22d ult. He telegraphed orders to all the officers and agents to make future reports to him, notifying them of the appointment of Mr. Munson as General Superintendent, and John L. Lathrop as treasurer.

The members of the city council of Terre Haute, Ind., met at the council chamber in called session, and passed resolutions testifying to the regret with which had been received intelligence of the death of Joseph Strout; recalling the estimation in which he was held as a man and as a citi en; recording his high qualifications, careful, painstaking and faithfulness as a civil engineer of the city of Terre Haute, and agreeing that the city officeçs and members of the council should attend the funeral in a body, at 2 o'clock on Sunday, 28th October.

BRIDGES.

Byron, Wis., is to have a $27,000 iron bridge across Rock river.

The railway bridge across the Wabash at Peru, Ind., which was burned two weeks ago, is to be replaced by one to cost $100,000.

There is some talk of erecting a handsome iron bridge over the Flint river at Saginaw street, Flint, Mich., as a substitute for the unwieldy wooden affair now in use there.

The officers of the town of Pecatonica, Winnebago Co., Ill., recently awarded the contract to the King Bridge Company, of Cleveland, for the erection of a bridge of three spans of 78 feet each, to replace the structure which lately fell in that town.

The westerly caisson of the bridge across the Hudson river, at Poughkeepsie, N. Y., which the American Bridge Co., of this city, are constructing, is fixed on the solid gravel bed ninety-seven feet below the surface of the water. The second caisson is sunk seventy-five feet below the surface. The depth of the mud is greater than with the first pier, so that a foundation will be secured 112 feet below the surface. Both these caissons are immense timber structures, and will be filled with solid concrete to a point twenty-five feet below the surface, where the granite pier will begin. All the piers for this bridge will be sunk to a depth greater than that of any bridge piers in the world.

Last Saturday night at Silver Creek a force of 200 men began the tearing down and re-building of the Detroit & Milwaukee R. R. Company's bridge over Grand river, at Grand Rapids, Mich. The old bridge was a wooden truss structure. The new bridge is of the plate girder style, of iron. It is 620 feet long, composed of five spans each 100 ft. long, and 10 feet deep, and two that are each 60 feet long by five feet deep. The total weight of the structure, exclusive of ties and rails is about 232 tons, each of the long spans weighing a little more than forty tons. The track on this bridge was raised between six and seven feet, which necessitates the raising of the approaches and the doing of work equivalent to grading 1,600 or 1,800 feet of roadbed an average of three feet. The crew worked through continuously with the exception of five hours Sunday night, when the wind blew a gale, and the new bridge was completed ready for use at 5 o'clock Monday evening. The spans were all finished at the Detroit Bridge and Iron Works, and were moved ready to set up in their respective places in the bridge. It is the first time in the history of bridge-building that such a feat has been accomplished, and is, hence, something notable. There were no accidents or mishaps, and the new bridge is the finest in the State. The total cost of the improvement is about $40,000. Chief Engineer Masson and Master of Bridges Garrick, of the Detroit & Milwaukee Company, superintended the erection of the structure, assisted by President Pope, Superintendent Robinson, and Engineer Baker, of the Detroit Bridge Works. President and Receiver Trowbridge and Superintendent Callaway, of the Detroit and Milwaukee Company, also gave their personal attention to the work, and are all elated at the success of so important an undertaking. It is estimated that the bridge will easily sustain ten times the weight that will ever be placed on it. No extra men were employed, the work being done by the Bridge Company of Detroit and the the Bridge Department of the railway.

GAS AND WATER-WORKS.

The Newport, R. I., $400,000 water works are Geo. H. Norman's private property.

The village of Saratoga Springs, N. Y., has recently completed a branch track from the railroad to the Holly waterworks which force the Loughberry water through the distributing mains. By this track they save a cartage of coal of about two miles.

Providence, R. I., people are anticipating a reduction in the price of gas for heating purposes to $1 a thousand feet, and several parties are preparing to attach gas pipes to their furnaces, abandoning the use of wood and coal altogether.

The board of water commissioners of San Francisco, on Oct. 18 formerly accepted the proposition of the Blue Lakes Water Company to bring water to the city for $13,500,000. As soon as the necessary preliminaries are accomplished the question will be submitted to the people.

A preliminary survey has been made looking to the introduction of water into the main village of Hillsburgh N. H. It is proposed to build a large reservoir near the top of the high hill northwest of the village, distributing the water to all the houses in the village, and also in three reservoirs, one at each end of the village, and one in its centre, with hydrants at proper intervals. The survey made, shows that the water can be thrown from a hydrant over the highest steeple in the village. The size of the pipe has not yet been determined upon, but will probably be a 4 inch iron pipe.

The Gas company of Lawrence, Kansas, has accepted the proposition of the city council. Henceforth there will be light. The substance of the proposition is that for three years the city will pay the gas company $22.50 per year,—this is to include all costs for lighting, extinguishing, cleaning, replacing broken globes and defective lamp cocks; the lamps to be kept lighted until midnight. During three years the gas company will pay the city the sum of $3,300 in equal monthly instalments, which amount will be used by the city to satisfy the claims of Arabella J. Newlin against the city; these installments to be deducted from the bills of the gas company.

The village of Johnstown, N. Y. is about to commence the construction of water works under the direction of P. H. Baermann C. E. Engineer. Tenders are invited.

The New York *Sun* says: "It is doubtful whether the reign of gas will last much longer. At the present time nearly every shop in Brooklyn is lit, and brilliantly lit, with kerosene, without any disagreeable odor being perceptible; while a few months ago the authorities in the large city of Exeter, England, would not enter into new gas contracts, as they anticipated the use of electric lights, and at Bristol, England the authorities have lately resolved to advertise for tenders for lighting the whole or part of the city otherwise than by gas, in the event of no satisfactory arrangement being come to with a gas company.

"Colonel Charles Thomson Jones, Chairman of the Water Committee of Philadelphia, reported to Select Council with a favorable recommendation, an ordinance to pay the sum of $2,500 for the privilage of laying a forcing main through his property to utilize the Worthington and Cornish engines at the Roxborough Water Works, but Mr. Bickel objected to the adoption of the bill for the reason that he believed $2,500 was too large a sum, particularly when the property through which the water-main was to pass was only assessed at $12,000. The ordinance was referred back to the Water Committee.

CONTRACTORS.

Proposals are invited for the construction of water works for the village of Johnstown, N. Y. Particulars are given in the column of "Proposals for Contracts" in this issue of ENGINEERING NEWS. The peculiar feature in the proposal for this work consists in a "lump sum" bid being required for the complete work.

About $3,000 will be expended in dredging the harbor at Southport, Conn., under the government appropriation, and the work will be commenced at once.

The Chicago *Tribune's* Washington special says the Supervising Architect will ask an appropriation of $800,000 to complete the Chicago Custom House.

The people of Owego, Tioga Co. N. Y. are to vote at special election in November to see whether or not they will raise $12,000 for the purpose of building a high school.

The contract for the erection of the Pennsylvania car shops at Twenty-eighth street, Pittsburg, Pa., have been awarded to Geo. Cochran, of Allegheny, and R. W. Gibson of Lewistown, Pa.

The Southern penitentiary commissioners at Springfield, Ill., Oct. 26th awarded the contract for supplying the cut-stone for the prison at Chester to the Commissioners of the Joliet prison at $14,000, and for the construction of the prison to Baltes & Nelson of Fort Wayne, Ind., at $85,000.

The Board of State Engineers, of Louisiana, have adopted the rule that hereafter when a contract for constructing levees is adjudicated, the lowest bidder shall at once deposit one per cent of the cash to be received for the 20,000 yards of filling, and one quarter of one per cent for every additional yard. It is made a condition that this sum shall be forfeited to the State in case of failure to sign the contract, and furnish solvent security on the day stipulated. It is beleived that during the current year there will be completed eleven hundred thousand yards of levee. Major Harrod has left New Orleans for the parishes of Iberville and East Baton Rouge, to stake out new work. The amount to be expended upon new levees, between now and first of January, is estimated at between two hundred and twenty-five and two hundred and forty thousand dollars. The estimates for next year are based upon an assessment of one hundred and seventy millions, allowing 20 per cent for the cost of collecting taxes and for delinquents. It is believed by the board of engineers this will be sufficient for the work absolutely necessary, but they have no hesitation in saying that, did the aggregate country assessment equal that of the city, Louisiana would never again have good reason to complain of the condition of her levees. According to their calculations, with an assessment of $222,000, three-fifths of two mills—the sum devoted exclusively to the construction of levees—would amount to $600,000 per annum, a fund sufficient to keep every levee in the State in thorough repair. In view of the fact that this large sum would be expended entirely in the country, and would greatly improve all real estate in the vicinity of the construction, it is considered only fair that parties interested should bear at least an equal share of the expense.

RAILROADS:

The St. Clairville, O., narrow-gauge road is unable with its present equipment to supply the demand for coal.

The Boston and Albany R. R. has declaired a dividend of eight per cent. on the capital sthck of $20,000,000.

New sidings on the Scioto Valley road, O., have been put in at Lucasville, Sargents, Piketon, Waverly and Sharonsville.

The new Board of Directors of the Bellaire and Southwestern narrow-gauge propose to raise $15,000 at once for the purpose of laying the track from Bellaire to Wegee, O.

A confidential circular has been issued by General Manager Broughton, of the Great Western R. R., Canada announcing his intention to restore the old rates of pay November 1.

The track on the Snow Fork branch of the Columbus and Hocking Valley, O., will be laid to Ogden's furnace by November, 7.

Chinese authorities have officially taken possession of the railway between Woosung and Shanghai and stopped all traffic thereon.

The Wabash R. R. company will build a branch from Edwardsville to Alton, Ill., provided the people will pay the expense of construction.

It is proposed to build an elevated railway along the docks at Liverpool, England, about three miles in length at a cost of about $700,000.

The New York Central people are going to build a railroad from Schenectady to Saratoga Springs, that will be especially convenient to Western travelers.

It is now considered certain that the new Syracuse, Geneva and Corning R. R., N. Y., will be continued to Lyons in the spring. The route has been surveyed.

The Great Indian Peninsular Line have ordered 140 new engines. Other companies are also taking advantage of the present low prices to lay in a stock of materials.

The Monday Creek branch of the Hocking Valley road, O., will be completed to Monday Creek furnace, and in the spring finished to Craft's furnace. The bridge over Monday creek is completed.

The Panama R. R. will not likely be a very popular route for the health seeking public. During its construction eighty-one thousand lives were lost by malaria, or about a man for every yard of its length.

An ordinance authorizing the Mayor and City Council of St. Joe to dispose of the bridge over the Missouri river at St. Joseph, Mo. to the Union Pacific R. R. Co. was adopted Oct. 26th by an almost unanimous vote of the people. There was not enough oppsition to draw out a very full vote.

MISCELLANEOUS.

A three foot vein of coal has been discovered in Union township, Crawford county, Pa.

The electric light at the depot of the Paris and Lyons Railroad is now one of the sights of the French capital.

The total amount of iron ore shipped from the Lake Superior country this season, up to the 11th ult., was 864,070 gross tons.

The Secretary of war will estimate two millions of dollars for fortifications, and thirteen millions for river and harbor improvements.

There is a tank in the Westminster Aquarium, London, capable of containing 94,000 gallons of water. It is 150 feet long and 20 feet broad.

The starting of the Woodruff scientific expedition around the world, which was to have taken place this month, has been postponed till May 15, 1878.

Virginia and North Carolina are holding meetings to urge a congressional appropriation for the improvement and enlargement of the Dismal Swamp canal into a ship canal.

The whole sum needed for the transportation and erection in the city of New York of the Egyptian obelisk, now standing at Alexandria, is said to have been secured.

James B. Eads has further reason to be happy. The steamship Teutonia, drawing twenty feet and nine inches, recently passed into the Gulf of Mexico through the Southwest Pass of the Mississippi.

The canal connecting Spring Lake with the Illinois river, Ills., has been completed and accepted by the commissioners. It cost a little over $4,000, leaving $2,000 of the appropriations unexpended.

The people of West Point, Georgia, are taking interest in a proposition to dredge the Chattahoochee above that town, so as to permit the navigation of that part of the river. They will endeavor to obtain an appropriation from Congress.

It is said that a stock company is forming in Philadelphia with a capital of $1,000,000, divided into $100,000 shares, a portion of which is to be applied to the culture of silk in the rural districts of Pennsylvania, New Jersey and Delaware.

The preliminary work for the draining of the Zuyder Zee is being accomplished with energy. It is estimated that the entire enterprise will occupy sixteen years, and cost $67,000,000. The lands rescued from the sea are expected to return more than the sum expended to drain them.

The first news from the Polar expedition is not reassuring. Capt. Tyson reports continuous rough weather and great suffering. The mission of Capt. Tyson was to establish the quarters where Capt. Howgate is to pass the winter, so as to make an early start next spring for the North Pole.

At Ottawa, Canada, Mr. Venner lately paid off the party who were engaged all the summer exploring the Gatineau and Lievres rivers. They have prepared a valuable map of phosphate locations in the Gatineau district. A new phosphate mine has been discovered near Arnprior.

American inventors have the opportunity offered them to secure a valuable prize. For a new process to extract the juice of the sugar cane, at a cost not exceeding 40 per cent. of the market value of the product, the Council General of Guadeloupe offer a reward of $20,000; the descriptions to be submitted by the 1st of June, 1880.

The sea route to Siberia, opened to commerce by Professor Nordenskjold, has been traversed by several vessels during the past season. The steamer Frazer, which left Bremen for the Yenesei, July 28, returned to Hamerfest Sept. 24. September 16 a vessel arrived at Vardoe after a passage of twenty-one days from the mouth of the Yenesei.

The island of Java is 620 miles long and 125 miles across in its widest part. The soil is one of the richest in the world. Palm and cocoa trees grow to the height of 150 feet. Its forests furnishes trees lofty enough for the masts of large ships, while teak supplies the place of oak for ship building. It is the most durable of woods. The population is 10,000,000.

The people of Grafton and Alton, Illinois, or parties interested, will, it is reported, shortly institute proceedings to enjoin the Southern Penitentiary Commissioners from proceeding further towards the building of the prison at Chester, Illinois. The allegations of the complainants are that Chester does not fulfil the requirements of the law as a location.

The U. S. Dredge Boat "Essayons" formally at work at Southwest Pass, Mississippi river, is going to Sabine Texas, to cut a channel through the bar there. This is an experiment and if successful will prove of much importance to the Hydrographical Engineer. A survey of that bar made last July shows but 7.3-10 ft. in the channel, and that for some distance.

The project of a tunnel under the Detroit River, Mich., is still moving. The capitalists who are to furnish the money for the work, will go ahead as soon as they receive a guarantee of $200,000 patronage a year from the railroad companies interested in such improvement. A distinct offer has already been made by the Great Western and Superintendent Ledyard, of the Michigan Central, is considering what offer his road shall make.

Capt. Davidson of the United Coast Surveying corps, accompanied by Messrs. B. A. Coleman, J. F. Pratt and Ben Berndt, visited Empire City, Oregon, for the purpose of "spying out the land" preparatory to extending the coast survey next summer. They secured the services of a guide and started out to explore the Coast mountains in order to find, if possible, a suitable country through which to run a base line, from which they can connect with the coast survey.

There is considerable interest manifested among the seafaring men in the vicinity of Marblehead, Mass., in regard to the necessity of a lighthouse on "Half-way Rock." This rock is three miles out in the ocean, about half way between Boston and Cape Ann, and, being in the vicinity of some of the most dangerous rocks and reefs on the coast, is considered the best place on the coast for a first-class light, which is greatly needed. A petition is being circulated, for signatures, asking Congress to build the lighthouse, and it is said that Dr. Loring and Gen. Butler are both in favor of the project.

The great Sutro tunnel approaches completion and the Superintendents of mines along the Comstock lode have arranged for a careful investigation as to the cost of the tunnel, the benefit it is likely to prove to miners, the cost of pumping water to the surface from the tunnel level, etc., as a basis of arrangements for permanent future operations. Col. Fair says, relative to the proposed compromise between Owens, of the Comstock mines the Sutro Tunnel Company, he considers that any proposition looking to the payment of a certain sum by each mine proportioned to its length of lode would be absurd. Some of the mines are very dry, others very wet, and in some cases such contract would amount practically to confiscations of mines. As an instance in point, he cited the Sierra Nevada, whose assessment at the proposed rate of $3 per foot, would be $10,000 per month in addition to present expenses. Colonel Fair holds that the tunnel will be valuable for draining mines and should be liberally paid for that service, but claims that the only proper basis of contract would be one which took into consideration the amount of water drained from each mine. This, he says, could be easily ascertained and paymeuts made to reimburse the Sutro Company.

The history of the Western Union Telegraph Company is probably the worst illustration extant of the evils of watered stock. This Company grew out of the New York & Mississippi Valley Printing Telegraph Company, which was organized in 1851. The Western Union was incorporated in 1856, and was a consolidation of the Company named above with the Lake Erie Telegraph Company. At that time the combined companies owned 1,400 miles, representing an actual outlay of only $360,000. The first watering of stock took place in 1858, when a stock dividend of 414 per cent was made; then followed dividends in stock in 1862 of 27 per cent., in 1863 of 100 per cent., in December of the same year 33⅓ per cent; then an issue of $2,000,000 stock to pay for purchased lines; and in 1866 a a dividend of 100 per cent. in stock was made. At that time the capital stock was $22,000,000, and since then, by new issues for the purchase of rival lines, etc., it has been increased to $41,073,410, of which $7 255,335 is held by the Company in its own Treasury. In twelve years after its organization the Company had a capital of $20,000,000, which cost the stockholders less than $400,000. The first dividend in money was 8½ per cent., paid in December, 1857, and within ten months thereafter 74½ per cent. in dividends had been paid. Besides the enormous stock dividends that were made between 1858 and 1866, the cash dividends averaged about 7 per cent. a year. Between July 1, 1866, and June 30, 1877, the dividends were $12,121,987.34.—*Chicago Tribune.*

PUBLICATIONS RECEIVED.

Fret Sawing for pleasure and profit. Henry W. Williams. New York, 1877. Price 50 cents.

The Sanitary Condition of City and Country Dwelling Houses. By Geo. E. Waring Jr. No. 31, Van Nostrand Science Series. Van Nostrand, New York. Jansen McClurg & Co., Chicago. Price 50 cents.

The Jericho Road. By John Habberton. Chicago: Jansen McClurg & Co.

We would refer our readers to the almost universal approbation with which the Press of the country received the above book. The mystery which at first enveloped it, and the celebrated men to whom its authorship was accredited has thoroughly established its reputation.

Six Little Cooks. Jansen McClurg & Co. Chicago, 1877.

We know from experience that engineers are often placed under circumstances where "Six Little Cooks" would be a great acquisition. We would decidedly recommend this work as being "handy to have in the house."

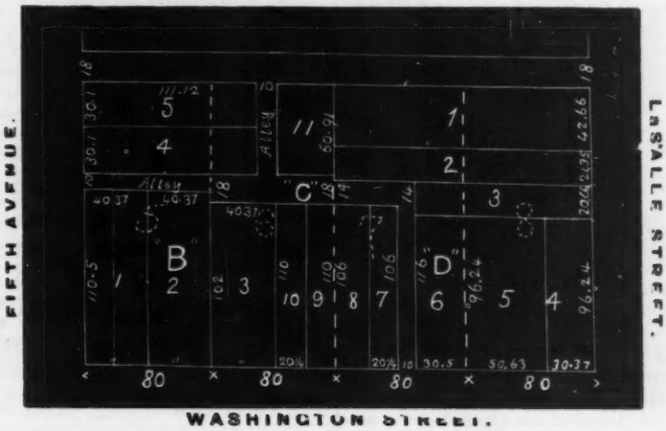
CITY SURVEYING IN CHICAGO AFTER THE GREAT FIRE OF 1871.

There wasn't any demand for surveyors for several days after the fire. One hundred thousand homeless people needed shelter from the cold October weather; and food and clothing were to be provided at once; business men, after the bewilderment of the first few days bethought themselves of where to find places to reorganize their business in, and the question of location and the price of rents were foremost in their minds. The latter unfortunately did not sufficiently claim their attention, and many shrewd, careful men of only recent days fell readily into the snares of leases set by as rapacious a crowd of sharks as ever infested a community. But once sheltered, and being assured that the world "still moved" the property owners of Chicago called for the Surveyors and Architects to go to work. Of the latter the number was Legion, as not only members of the profession from other cities flocked in, but dozens of draughtsmen started up full-fledged architects and announced their ability and readiness to design and superintend any structure from a cottage to a Courthouse. There was no increase among the surveyors. The business of locating city lots in Chicago has for many years been divided between not more than six surveyors, and even with the great amount of new work after the fire, the number was not increased. The reason was obvious. The landmarks were mostly all obliterated, the official records were all burned up, everything in the burnt district was chaos, and if ever there was a time when skill, local knowledge and judgment, were necessary to a surveyor it was at this particular time. New comers would therefore find difficulty in getting bondsmen to guarantee their work, and no one so well as the surveyor himself understood the risk he was taking in attempting to pick out from the piles of debris the little pieces of costly ground on which expensive buildings were to be begun as soon as he had marked the lines.

During the winter months the hauling away of debris went steadily on; architects were busy drawing plans, while lot owners were negotiating loans. With the opening of spring, operations commenced in earnest, and from that time on surveyors had plenty to do. Chicago real estate, like that of other cities, is cut up into very minute subdivisions; sections are laid out in blocks and lots, and these have been subdivided and resubdivided, streets and alleys have been laid out through them, and afterwards vacated and the whole or part resubdivided; some portions are subject to *prorata* measurements, and some are fixed by "meter and bounds," "assessor's divisions," made up from the deeds, are recorded by the hundreds, and numerous errors in former surveys in the records add to the responsibility of the surveyor who is called on to give the boundaries of any piece of ground in the business districts of Chicago.

The annexed cut shows the south ½ of block 40, Original Town of Chicago, and is a very fair illustration of how property is subdivided in the centre of the business district of this city. The half block was divided into four equal lots 80x180 feet, which are shown by the dotted figures 5, 6, 7, 8, and which were bounded simply by the streets, and the alley in the rear. At present B represents "Isaac Wanderpall's subdivision of lot 4 and west ½ of lot 6," D represents "King and Wood's subdivision of south part of lots 6, 7 and 8," but this subdivision has been replaced by an "Assessor's division of lots 7, 8, and west ½ of 6" and numbered accordingly; the lots have been intersected by alleys originally narrow, and C represents "widening of alley by Board of Public Works" assessment confirmed May 4th, 1868; sub lots 7 and 8 are shown to be by one survey 106 feet deep, and lots 9 and 10 adjoining and of equal depth are shown to be 110 feet deep, while an analysis of the dimensions of lots 3 and 4 and of the alley show them all to be about 103 feet. This property fronts east on the Court House square, and its southeast corner is diagonally opposite the Chamber of Commerce; it is built up solid with some of the most expensive buildings in Chicago, and the land being very valuable,—at the time of the fire fully $1500 per front foot,—the correct location of the buildings was very important, and an error by a surveyor was a serious matter for him as well as the owners of the property to be improved.

The original town was laid out with common compass lines, and it is not allowable to use adjacent blocks in getting street lines; each block is independent; the streets running east and west are not parallel to the section line on Madison street, and consequently are not at right angles to the streets running north and south, and every corner of every lot has to be fixed by chain measurements. The entire block was a mass of debris, made up of brick, stone, iron columns, and gas and water pipe; the sidewalks were broken in and there were no authorized marks or measurements from which to measure. The only way to make the survey was to measure as carefully as possible over the mounds of rubbish and note the face of every portion of brick wall standing, and of every mark left on stone piers by the fallen walls; then check on the curb stones of the



sidewalks on both sides of the street and by the remaining marks on both sides of streets; an analysis of the results by a competent surveyor would very nearly always furnish him with evidence satisfactory enough to warrant him in locating the boundaries of the lots, and after two or three buildings were erected the spaces between were easily marked off. The instruments used were the common transit, and the Grumman steel chain, 50 feet in length. In some cities surveyors affect extreme accuracy by using a thermometer and spring balance attachment. In this untutored city the surveyors are not educated up to such refinements, and do not care to be; they believe that they can measure just as accurately without these aforesaid "fixins" as with them, and can do twice as much work in a day. The writer gave the lines on property appraised at $4,300 per front foot, with a simple "Grumman," and there has never been any question raised as to its accuracy.

It was at all times difficult to make measurements; they were made along the old building lines where possible, and after the boundaries had been determined they were projected into the street and alley to any place where a nail could be driven or a notch cut in the curb, until the walls were properly started; sometimes, however, the measurements were made in the street, which was narrowed down to a mere roadway capable of allowing two teams to pass each other, and with the incessant passing of loaded wagons careful chaining became a difficult feat. However, the surveyors were equal to the occasion and comparatively few serious mistakes were made. The ornate architecture of the new buildings made it at times difficult to determine street lines; some building fronts had several different projections, and as it was not always possible to select the correct one, it became necessary for the contractor to be looked up and have him mark the street line; there were occasional differences of opinion among the surveyors, but on the whole their surveys generally agreed, and very few lawsuits have resulted from their errors. In the giving of street grades numerous errors crept in which have been perpetuated, and have not helped the appearance or uniformity of our stone sidewalks. "Giving grade" is a very simple operation, and there need never be an error if the "bench marks" are correct and ordinary care is taken with the level. But the bench marks were not always correct, and the surveyor, being in a hurry, did not always take the precaution to run his levels to another bench mark for a check, but took his chances, and a few days after had a fit of chills and his hair standing on end by a notification that the "grade was wrong," and somebody had to foot the bill for changes. Walls had to come down; foundations torn up, and the mischief was to pay generally. A ten-dollar fee seemed at such a time but a small compensation for such a risk. This kind of error didn't happen very often, but the following one did quite frequently. Grade is "outside" or "inside," the latter varying with the slope of the sidewalk from the curb at the rate of one inch in three feet; some surveyors *always* gave "inside" grade, some gave the other, and the masons figured accordingly; but they sometimes got "mixed," and the consequence was the sidewalk was too high by 5½ inches in a 66 ft. street, or too low, rarely the latter, and so these steps occur even in our most frequented streets; in some places the difference is but an inch or two between adjacent sidewalks, and the stone has been chipped off to an incline, but in some cases one has to step up or down the full five inches. And so they will remain for generations to come we suppose.

These were the halcyon days for the Chicago surveyors. Prices were good and clients numerous; one surveyor made $12,000 in fourteen months; others earned good incomes. Expenses were large in proportion, and the great demand was soon at an end; the panic found the Chicago fraternity poor in pocket, and by 1875 all but two or three had yielded to the pressure and had turned to other means of earning daily bread, and at the present writing there is not enough business in the city to support one surveyor's office. But the wheel is turning.

DURING the past week we heard of a man on South Halsted street in this city who adopted the novel and economical method of filling the half street in front of his lot with *flour barrels*, depositing and covering them at night, and over this filling the pavement was laid. Where was the puddling, the ramming, and the five-ton roller required by the city specifications?

WHILE on our way to Graceland one day recently we had to pass by where some block pavement was being laid, in being transferred from one car to another. "See," said a lady in passing, "what wood they are putting down! any person can see that it is already quite rotten." Where was the street inspector? Where the engineer?

CIVIL ENGINEERS' CLUB OF THE NORTHWEST.

The 78th regular meeting of the Club was held at the Sherman House Club Rooms, Chicago, Tuesday, November 3d, President W. Sooy Smith in the chair.

Members present were: W. Sooy Smith, E. S. Chesbrough, R. W. Potts, C. J. Roney, B. Williams, W. S. McHarg, D. C. Cregier, L. P. Morehouse, K. V Booth, G. F. Kirby, A. W. Paige, Fred W. Clarke, Max Hjortsberg, John A. Cole, O. B. Green, John W. Weston, Jas. R. Willett, J. Nichol, J. B. Howe.

The minutes of the last meeting were read by the Secretary, after which a ballot was taken and the following gentlemen declared elected: H. A. Rust, President of the American Bridge Co.; E. Hemberle, Chief Engineer, American Bridge Co.; A. J. Tulloch, C. E., and B. H. Bryant, C. E.

Proposals for membership: Thos. Franklin, C. E.,

Chas. H. Tutton, C. E., Tim. C. Bradley, C. E. and Wm. H. Hedges of the B. P. W. Sewerage Department.

The paper for the evening was contributed by E. L. Corthell, C. E., of the South Pass Jetty Works, New Orleans, entitled "Some memoranda on the South Pass Jetties," which was read by Gen. Wm. Sooy Smith, the Chair being occupied by Mr. E. S. Chesbrough in the meantime. The paper was accompanied by several charts, and a large number of specimens of material collected while sounding, and during the operations for the purpose of investigating the scientific phenomena connected with the jetty undertaking.

At the close of the paper Gen. Smith again took the chair and replied to some enquiries presented by the members, no active discussion taking place. Before adjourning the President called the attention of the members to the wonderful results of the metallurgical experiments conducted by Mr. Hayes, and to which he had drawn attention at a meeting of the club early in the year. The meeting then adjourned.

THE COURT HOUSE, CHICAGO.

Work upon the foundation for the new Court House in this city is, at last, well under way.

Although the City and County buildings occupy one site, have similar architectural features, and when finished will form one magnificient edifice, a carriage way passes through the block, between the lower stories practically isolating the municipal from the county offices, and gives them, for the time being, the appearance of two distinct buildings.

This fact has enabled the county officers to push the work under their control, untrammelled by the impediments which have hampered the city authorities; and such has been the energy displayed, that they have advanced the county building in all its principal parts to the second and third stories, while the authorities of the city of Chicago, from several causes, failed to commence operations in earnest until the beginning of October, when a contract to put in the foundations was awarded to Messrs. Mortimer and Tapper.

Apart from the delay from financial sources, there appears to have been a wide difference of opinion upon the subject of the nature of the soil upon which the new building was about to be erected, its characteristics as a material upon which to found, and its consequent stability under the enormous load it was destined to support. To the settlement of this important problem may, no doubt, be attributed a considerable waste of time, and the apparently short-sighted policy which postponed to the inclement season of the year the work of "putting in concrete" which of all materials used in constructive operations, requires the most careful manipulation, as well as protection from the deleterious effects produced by the vicissitudes of the weather.

As stated above, the contract was let in the early part of October, but unfortunately another serious delay took place on account of the severe storm about that time, which, in addition to its severity, continued long enough to postpone active operations for two weeks. Since that time, however, such rapid progress has been made that the contractors can, whenever it is deemed prudent, cease the "concrete" operations and transfer their whole force to the cut stone footings.

The plan of the substructure comprises: a bed of concrete, 3 feet thick, underlying all the main walls and piers, and projecting 2 feet beyond the lowest course of footings; upon the concrete three courses of cut stone are laid, of a total thickness of 3 feet 6 inches, setting back one foot in each course, and again upon this stone base heavy walls of bridge masonry are built to complete the foundation. A considerable quantity of brick work is also required in connection with the work in this basement.

The soil upon which the concrete has thus far been deposited proves to be quite a superior kind of clay, although to what depth the stratum extends is not ascertained; but the experience gained in driving the piles used in the foundation of the county building, when the earth displaced by the piling rose to the extent of from 3 to 6 feet above its original level, compels the assumption that it is better to "let well alone," and suggests the advisability of placing confidence in a heavy bed of good concrete on an aparently firm, and for what is known to the contrary, a safe soil.

The materials composing the concrete already deposited and completed in the North wall, and for a considerable length of the East and West walls, with the adjacent piers etc., consists of Louisville Cement, from the Western Cement Association, Chicago, Lake shore sand and broken stone, in the proportions of 1 part of cement, 3 parts of sand and 4 of broken stone. The work is performed entirely by hand labor. The cement and sand in their proper proportions are first thoroughly incorporated in boxes built for that purpose, thrown out upon the stone lying close at hand, the whole mass is then turned over, well worked, and afterwards wheeled to the trenches where it is deposited. The contract originally cited that the concrete should be "put in" in layers of 12 inches thick, but it has since been considered advisable to reduce this figure to 6 inches, to ensure greater compactness, and to allow a more judicious and effectual use of the "tamper."

Great care is being manifested by the contractors in the performance of this work, and due credit has already been accorded them. The materials on the ground are of the best. The sand is clean and sharp and the broken stone will gauge within the limits usually allowed by the inspecting officer. The work as it proceeds is carefully covered so that its surface may not be destroyed by the careless or uninitiated, and generally, from actual observation, if the capacities of concrete as a foundation are to be fully realized by proper attention and honest intention, the material supporting the walls of the new Chicago Court House will certainly uphold the standard.

The approximate quantities included in the contract awarded to Messrs. Mortimer & Tapper are as follows:

Concrete	104,000	cubic feet.
Cut stone in piers	8,700	" "
Bridge masonry	34,600	" "
Brickwork	33 500	" "

And the total cost of the same will amount to between fifty and sixty thousand dollars.

STREET TRAMWAYS*

BY ROBINSON SOUTTAR.

(*Continued from page 306*)

The second argument is, timber "decays rapidly, and requires to be often renewed." Though the timber bearings first laid in this country were, from inexperience, laid under a spiked rail, and often in a way which did not give the timber a fair chance, the Author is not aware that the timber of any tramway in the kingdom has been or is being renewed from any fault in the timber. He is connected with the two oldest tramways in the kingdom—severally eight and twelve years old—and can certify that the timber of neither has been renewed. The Authors of the book in question have perhaps been deceived by having observed the work of laying box and discarding flat rails, which is now being proceeded with by degrees wherever tramways had the disadvantage of being laid with flat rails in the first instance. As these wear out, box rails with side fastenings are substituted; and as the deep flanges of the box rail require a correspondi g rybat on the timber, it is evident that the timber must be changed with the rail. Mr. George Hopkins, an authority on tramway construction, says: I have frequent occasion in the course of alterations to take up sleepers that have been in use seven years, and I find the timber perfectly sound."

The argument is, "owing to its (timber) yielding nature, and to the fact of the sleepers being frequently deflected by passing loads, the fastenings of the rails work loose, and the difficulty of securing them is much increased." The Author admits this with regard to the old spiked rail, but he has not known any instance where a box rail properly side-fastened worked loose. Where he has found a loose rail it has been because the sleeper had not been pressed into the rail, or the side fastenings had been omitted or been broken by careless driving. It is evident that the firmness of this rail is simply a question of the number of fasteners, and, confined and kept tight to the sleeper as these are by the paving, it will be seen that they cannot possibly work loose. If the hole punched in the rail flange be slightly larger than the head of the fastener, it is evident that the rail will work up and down under varying pressure without the fastener being disturbed in the slightest degree.

*From Proceedings of the Institution of Civil Engineers, London.

So far, therefore, experience in tramway construction seems to prove:—1st. That the timber sleeper, by its elasticity, acting the part of a cushion for the rail and a buffer for the concrete, occupies a valuable position, but that this elasticity is not so great as to affect the paving in any way; 2nd. That the timber sleeper if laid with proper precautions, neither decays nor requires renewal, but will last whatever reasonable time the rail may be estimated to serve—say, from twenty to twenty-five years; 3rd. That the rail may be secured to any desired extent by simply increasing the number of side fasteners, and that these may be fixed in such a manner that they will neither wear nor break, but hold good as long as the rail endures.

The experience of iron tramways in this country is limited to one system, which has been laid in various provincial towns. The rail is supported on cast-iron chairs placed 3 feet apart. The earlier specimens were spiked through the groove, the spike going into a hard wood pin in the top of the chair. An improvement was made by the introduction of a side fastener somewhat similar to the one already described, the lower end being driven into a hard wood plug in the side of the chair. This system lacks advantages in fastening which the timber sleeper possesses. In the latter case both ends of the fastener penetrate into the wood, and the fastener therefore never springs out; in the former the upper end simply catches the rail, and must be apt to spring out. All the power of screw and lever are used to press the timber into the rail before the fasteners are driven home; and the wood when relieved from this pressure, has a tendency to spring back, and thus the fasteners are made doubly tight. Of course this cannot be done where wrought and cast iron are in the question. Further, the fasteners must be opposite one another, with iron chairs, instead of alternately as in timber, and the number of fasteners cannot be increased unless the chairs are increased.

It is proposed to construct the Manchester tramways with a continuous cast-iron bearing, to which the rail is held by iron pins. It is to be feared that the difficulty of constructing this system (entailing as it does getting the holes in the castings and the holes in the rails to correspond with delicacy) will be great, especially at curves and crossings; and that the rail will wear away more quickly on an iron bearing than on timber. Though it is possible that in a foreign country, where timber might be subjected to the ravages of insects, the iron tramway would be the only alternative, it is not easy to see what good purpose can be served by laying one in this country. An iron tramway must be expensive in the first place, troublesome to lay with accuracy, and most unmanageable when out of repair. It is not at all likely that an iron bearing, such as that proposed for Manchester, will last as long as a timber bearing, as there will be great wear at the fastenings; and even if it could be proved to be everlasting there would be little advantage, as the first cost would provide a fresh timber bearing every few years.

Part. II.—Mechanical Motive Power.

In the year 1873 a Select Committee of the House of Commons took into consideration the working of Locomotive Engines on Roads, and in their report recommended the following (p. x):

"That self-contained locomotive carriages (or engines), not exceeding 6 tons in weight, making no sound from the blast, and consuming their own smoke be classed as light, and that they be permitted to travel at the ordinary speed of vehicles drawn by horses, and only subject to the same restrictions as such vehicles." Before this date a law limiting the rate of speed to 2 miles per hour in towns was in force; and though various engineers had worked at the subject, and had discovered many of the difficulties that would have to be overcome in applying steam to tramways, practical men had generally hardly considered it worth while to spend time and money in working out an invention of which the legislature practically prohibited the use. Latterly, however, great energy has been shown in several cases with most encouraging results.

The difficulties which have to be surmounted in the invention of a tramway engine are so numerous that the railway locomotive is a simple affair in comparison. In the latter case power and endurance are the principal features; in the former much beside that is necessary.

Messrs. Hughes, of Loughborough, the inventors of

a steam car which is at present regarded with favor, put the particulars of a tramway engine very fairly as follaws: 1st. It must possess sufficient power to draw one or more loaded cars up steep gradients; 2nd. While possessing sufficient weight to grip the rails, especially on steep ascents, it must at the same time not be so heavy as to press injuriously on the rails; 3rd. It should possess very powerful brakes, so that it can be stopped almost instantaneously in a crowded thoroughfare; 4th. It must be so contrived as to take the curves which exist on all tramways easily; 5th It must not emit its exhaust or any steam into the air; 6th. It must be smokeless; 7th It must not produce any noise in working calculated to alarm timid passengers and horses; 8th. Its machinery must not be visible, and yet be easily accessible; 9th. its fire must be concealed, especially at night; 10th. It must not present an unsightly appearance; 11th. It must not require more than one attendant to work it; 12th. It must be reversible, *i. e.* capable of going backwards or forwards with equal safety; and 13th. If possible, it should be so simple in construction and working that in can be driven by an unskilled man.

When these, which may be termed the external difficulties, have been met, then many internal difficulties at present only guessed at, will arise, and though it is not contended that these difficulties are insuperable, still there is much to be accomplished before other than animal power can be used extensively on tramways. Neither is it desirable that the change, if change there is to be, should be unduly hastened, lest by the introduction of imperfect engines public prejudice, at present dormant, should be again aroused.

The tramway engines hitherto experimented with at all successfully have been of three classes:

1st. Steam engines and car in one, as Grantham's,
2nd. Steam engine separate from car, as Hughes, and Merryweather's.
3rd. Pneumatic car and engine in one, as Scott Moncrieff's and Mékarski's.

There is some difference of opinion as to whether it is more desirable to have the engine and car combined or separate, and substantial arguments may be urged on both sides. It is argued, on the one hand, that with a detached engine there must be a great deal of shunting at the beginning and end of the journey, and with tramways as at present laid this argument is very forcible; the Author having witnessed experiments where the changing of the engine from one end of the car to the other was a most tedious process. But the difficulty could be overcome to a great extent, in some cases by laying a circular line at the terminus, in others by a V shut up a side street, and where neither is practicable by double cross-overs. Again, with a detached engine the difficulty of passing round quick curves is increased. It is likely that on a curve, say of 40 feet radius, the car would be occasionally pulled off the line. This objection is valid where quick curves are essential, but in many cases tramway curves are unnecessarily quick, and if mechanical motive power is introduced the tramway constructor must meet the difficulty by making the curves as easy as practicable. In the matter of adhesion, the detached engine is evidently inferior to its rival. Where the car and engine are combined it will not, probably, matter much how great the load on the car is, as the adhesion will increase in proportion; whereas if the engine is separate, the weight it can pull after it will be a known quantity, and will be just that portion of the whole tractive force which is more than sufficient for itself.

On the other hand, the detached engine entails less alteration to rolling stock, and permits of two cars being drawn by one engine on special occasions. The design of engine and car combined must be greatly cramped; the separate engine can be designed with greater freedom, and in it the experience gained in connection with railway locomotives can be more fully taken advantage of. Though it is claimed for the Grantham steam car that the boilers are perfectly safe, and that the passengers experience no disagreeable sensation from the heat, it is to be feared that this state of things will not improve as the car becomes older, and it will be a long time before timid prssengers will sit beside a boiler with complacency. Where detached engines are employed a smaller stock of engines will do the work, as in case of accident to the car, it can be unhooked and another attached. Where engine and car are combined a trifling accident will cause £300 to lie idle. In the matter of repairs generally the detached engine will be greatly superior to the combined. In the former case the engine can be removed at night and cleaned or repaired in a suitable engine shed, in the latter, the fittings of the car will be quickly soiled and damaged by the smoke and dirt incidental to engine repairs and cleaning.

From these considerations it is likely that detached engines will be used more generally than combined. At least this will be the case where steam is used. With compressed air the case is different. The machinery necessary to drive a car by compressed air is comparatively simple, and can be accommodated under a passenger car in a manner neither dangerous nor disagreeable to the passengers. This seems satisfactorily proved by Mr. Scott Moncrieff's car. If heating is resorted to, as in M. Mékarski's, it becomes a question whether the detached engine will not again be more suitable.

1. *Steam Engine and Car combined.*—The steam carriage designed by the late Mr. John Grantham, M. Inst. C. E., is slightly longer than an ordinary car, and has two boilers, so placed on each side in the centre of the car, that a continuous passage is maintained throughout for passengers. The driving wheels are of a larger size, and there are four smaller wheels on a bogie frame. The car can be driven either way and from either end, and is well under the drivers control. It complies with the Board of Trade regulation, which renders it necessary that the speed should be limited by automatic machinery to 10 miles per hour. A stoker is required, and the objection caused by the escape of smoke and steam is not entirely abated. A Grantham steam car is at work on the Wantage tramway. It weighs empty 6½ tons, and when fully laden with fuel and passengers over 12 tons. It cost £800.

2. *Detached Engines.*—Messrs. Merryweather & Co. have many engines at work, chiefly on the continent. Those used in Paris weigh, when laden with fuel and water about 3½ tons. The boilers are multitubular, 6 feet long and 2 feet 6 inches in diameter. The two cylinders have a diameter of 6 inches, with a length of stroke of 10 inches. The working pressure is about 100 lbs., and the consumption of fuel 20 lbs. per hour. Each engine has ordinarily attached a car containing, when full, forty-eight passengers, which it draws up various ascending gradients, the steepest being about 1 in 30. The engine is perfectly under control, and can be propelled at any required speed at the will of the driver. The brake power is a foot brake, which acts on all the wheels at once with rapidity and effect. Various ingenious contrivances can be applied to these engines for increasing adhesion and power on heavy inclines. The exhaust steam from the engine is disposed of partly by condensation, viz. by mixture with dry air, by passing through diaphragms of wire gauze, and through a surface condenser; the residue is led into the smoke-box, and escapes in a superheated state. The speed of the engine is controlled by a governor, driven by the rotation of the wheels and acting upon a throttle valve. In the course of experiments on the Vale of Clyde tramways, it was found that, notwithstanding the apparent completeness of the methods for getting rid of the smoke and steam, the escape was still somewhat objectionable. The manufacturers believe they will be able to improve the engine in this respect, and it is to be hoped they will be successful, as no engine has a chance of succeeding in this country which renders outside traveling impossible or even disagreeable. In Paris a stoker accompanies the engine but as it seems that his chief duty consists in blowing a horn, Messrs. Merryweather think his services might be dispensed with in this country. It is desirable that, on a tramway engine, not only the stoker, but the operation of stoking during the journey should be unnecessary.

The steam tramway engine designed by Messrs. Henry Hughes & Co., of Loughborough, is at present giving great satisfaction. It is heavier than Messrs. Merryweather's, weighing 4 tons 15 cwt. empty, 6 tons loaded. The cylinders are 7 inches in diameter, with a length of stroke of 12 inches. The wheels are 24 inches in diameter, and coupled. The exhaust steam is got rid of by condensation. The condenser is subdivided by horizontal perforated partitions, down which a stream of cold water gradually falls, condensing during its descent the ascending currents of steam from the exhaust ports. The water of condensation is allowed to flow on to the road; or when this is objectionable, to accumulate in a tank under the tramway carriage, from which it is discharged at the end of the journey. Coke is used as fuel, and the amount of smoke and steam that issues from the roof of the engine is trifling, certainly not enough to annoy passengers. The firing of this engine is completed before it starts on its journey, and is not disturbed until the journey is complete. In this way much nuisance is doubtless saved, and the services of a stoker are rendered unnecessary. Messrs. Hughes endeavoured so to arrange their engine, that all the work requiring technical knowledge could be done before the engine started on its journey, and thereafter the engine could be driven by one, and he an unskilled, man. This principle has certainly been carried out, the engine being so constructed that the driver can perform every required service on ordinary occasions without moving from his seat in front. On the level, and on gradients as steep as 1 in 30, this engine can do all that would be required of a tramway engine sufficiently well; but on gradients of greater inclination than 1 in 30, the Author thinks that neither this nor any other engine he has seen could be trusted to stop with a laden car behind and start again without trouble and delay. Still it is not right to draw absolutely adverse conclusions from this opinion. In actual practice it would not be necessary to stop an engine on a stiff incline unless it was a long one. On a well-managed tramway the horse cars would not be stopped under similar conditions. Though there are tramways that could not, owing to their gradients, be worked successfully by steam power, there are, in a majority of cases no insuperable engineering obstacles. At the same time, it will probably be longer than some imagine before steam engines will be allowed to run to any considerable extent in towns.

3. *Pneumatic Cars.*—A pneumatic car designed by Mr. Scott Moncrieff, has been at work on the Vale of Clyde tramways for some time. The car is in appearance like an ordinary passenger car, but the floor is more elevated. Under the ends of the floor three reservoirs, 6 feet long and two feet in diameter, are placed, and these, when charged, contain 100 cubic feet of air at a pressure of 350 lbs. per square inch. The machinery lies between the reservoirs, under the middle of the car. Mr. Scott Moncrieff says, in a description of the car, "The principal obstacle with which inventors have had hitherto to contend in utilizing compressed air at high pressure is the excessive cold that is produced in the exhaust, and this has proved fatal to all applications of compressed air for locomotive purposes up to the present time. In any mechanical arrangement, such as a locomotive carrying a definite quantity of compressed air, and absent from time to time from the original sources of supply at the pumping stations it is absolutely necessary that the fullest advantage should be taken of the limited power stored in the receivers. The only way in which this can be done is by using the air expansively, and as the pressure is always decreasing towards the end of the journey, this expansion must vary correspondingly.

"By an arrangement of valve gear suited to these requirements, the air is always exhausted in the Scott Moncrieff system at the atmospheric pressure, the effect of which is not merely to obviate the difficulties arising from excessive cold, but also to propel the car in silence, and utilize to the utmost the available power."

It is impossible to judge fairly of the value of Mr. Scott Moncrieff's car under the circumstances presented on the Vale of Clyde lines. The car there is the first, and is, as might be expected, roughly constructed and unnecessarily heavy. The pumps for compressing the air are of a temporary character, and there is no proper storage for air, so that the process of charging is exceedingly tedious, occupying an hour each journey. Under these circumstances it is rather remarkable that the car should have achieved even a degree of success, and been able to compete not discreditably with steam cars. Mr. Moncrieff is now building a new car of a larger size, and with greater capacity for storing air, and as he will be able in this car to take advantage of the improvements that experience has suggested, it is likely that even more satisfactory results will be arrived at.

M. Mékarski, of Paris, is the inventor of a tramway

engine and car combined, driven by compressed air heated before admission into cylinders. The reservoirs, thirteen in number, are cylindrical, and lie crosswise under the floor of the car. They contain when charged 70 cubic feet of air at a pressure of 375 lbs. On the front platform stands a vertical vessel filled with water at a high temperature. The compressed air enters at the underside of this vessel, and bubbles up through the water, thus becoming charged with vapor. By a reducing arrangement the air can be admitted into the cylinders at any required pressure. From this car very good results are said to be obtained. The method however, appears complicated, and the position of the hot-water vessel makes it necessary that the car should travel one way only. The weight of the car must be considerable, and it is possible that when compressed air is proposed to be used in this way, it will be found better to have a detached engine.

Part III.—Financial.

The cost of tramways is affected by so many circumstances that it would only be misleading to attempt to give an estimate. The price will vary from £1,500 to £6,000 per mile of single line, according to the design recommended for the particular road to be traversed and the price of materials at the time and place. A Table is annexed showing, as fully as practicable, the present position and progressive development of nine tramway companies. This Table attests the remarkable success achieved by tramways in this country within a few years. From it almost any information that can be desired on the subject of working expenses may be easily procured.

It is not easy at present to make any reliable comparison between the relative cost of horse and steam power on tramways. If attempted, it would be sure to err in favor of steam, from the fact that while experience has taught the worst that can be learned about horses, as yet the best only has been seen of engines. Where steam is introduced there will probably be a substantial saving, but less than the advocates of steam locomotion predict. The wear and tear of engines by mud getting amongst the gearing, sudden stoppages, collisions, jerking over stones in the groove, and running off lines, would be enormous. The repairs will entail the services of a staff of engine-fitters, and after a few years, when the engines became worn, workshops with expensive machinery and manned by expensive men will be erected. The nightly cleaning of the engines will be formidable, and can only be satisfactorily accomplished by skilled men. Horse-driving requires little skill, and it is easy to find drivers who will work long hours at a low rate of wages; but engine-drivers will require high wages, and will most likely decline to to work twelve or thirteen hours per diem. Indulgence granted to drivers in this respect would have to be extanded to conductors, and in this way complication and expense would arise. It is to considerations such as these that the hesitation to recognise the value of a change from horse to steam power is to be attributed, rather than to prejudice.

In the following memoranda the actual cost of working a car by horses is contrasted with the probable cost of working by steam and air. The cost of fuel for steam power is taken from recorded experiments. The cost of fuel and fixed machinery in the third estimate is taken from Mr. Moncrieff's statement. In such matters as wages, repairs cleaning, spare engines, etc., the Author has followed his own judgment, and the figures are somewhat higher than ordinary, but in practice they would probably be low enough. The wages of the engine-driver are taken as higher than the car-driver's wages. Most inventors claim that their engines can be driven by an unskilled man, and though this may be correct, it would be none the less extremely injudicious to trust unskilled men with them One cleaner is allowed for every three engines. Such expenses as management, rent, interest on outlay, etc., are not included, as these would be about the same in any case. The spare engines are taken at 25 per cent., and, considering accidents and periodical overhauling, this number would not be excessive. It is always to be remembered, however, that whilst the cost of horse power has been ascertained with absolute certainty, the cost of mechanical motive power is, to some extent, an unknown quantity.

Estimate No. 1—Cost of Horse Power per Diem.

	£.	s.	d.
Forage for ten horses and one spare horse at 2s.	1	2	0
Veterinary attendance and shoeing	0	2	2
Depreciation of horses	0	6	3
Harness maintenance, renewal, and cleaning	0	1	1
Horsekeeper 3s. 6d., car-driver 5s., conductor 3s. 6d.	0	12	0
Per diem	2	3	6

Or assuming 60 miles per car per diem = 8⅗d. per mile.

Estimate No. 2.—Cost of Steam Power per Diem.

	£.	s.	d.
Fuel, oil, and water, 1d. per mile	0	5	0
Renewal of engines, 10 per cent.	0	3	3
Repair of engines, 1d. per mile	0	5	0
Interest on 25 per cent. spare engines	0	0	4
Engine cleaner (⅓) 1s. 6d., driver 6s. 6d., conductor 3s. 6d.	0	11	6
Per diem	1	5	1

Or at 60 miles per diem = 5d. per mile.

Where a stoker is necessary the rate would be 5⅗d. per mile.

Estimate No. 3.—Cost of Pneumatic Car per Diem.

	Pence per mile.	£.	s.	d.
Enginemen and firemen for fixed engines	0.125			
Depreciation of fixed machinery	0.125			
" cars	0.625			
Fuel, oil, etc.	0.500			
Contingencies	0.272			
	1.647 × 60 =	0	8	3
Repair of car engine 1d. per mile		0	5	0
Interest on spare engines		0	0	4
Cleaner (⅓) 1s. 6d., driver 6s. 6d., conductor 3s. 6d.		0	11	6
Per diem		1	5	1

Or at 60 miles per diem = 5d. per mile.

Part IV.—Tramway Carriages.

The cars for the New York and Harlem street railway were built in 1832 by Messrs. John Stephenson & Co., of New York. These cars had the features of ordinary road coaches, viz. a carriage part independent of the body, elevated driver's seat, side-doors, and leather springs.

Springs.—The wear of the lower part of this description of vehicle proved to be so great, that it was soon found necessary to unite the carriage part to the underframe, to place the springs under the body, and to substitute steel for leather. At first the axle-box was fixed to the spring on the underside; but this was unsatisfactory, the adjustment of wheels and axles not being positive; and the single pedestal, which permitted the car to move in a vertical plane only, was introduced. In 1858 a further improvement was made; a yoke being placed on the axle-box, each end of which yoke sustained a spring, thus giving two springs to each journal At the same time steel spiral springs were introduced, and these, in turn gave way to india rubber, which last are now almost universally used. The rubber is prepared in a way which makes its elasticity practically independent of temperature, and increases its power of sustaining burdens. The india rubber springs are cheap, durable, easily changed, not liable to sudden failure like metal springs, and give ease and delicacy to the motion of the car.

Wheels.—Much ingenuity has been expended in designing car wheels. Solid wooden wheels, with steel or wrought-iron tiers, were popular in England; but they are complicated; the tires are liable to work loose, and the endurance of the wheels does not justify their cost. Wheels with wooden spokes were attempted, but speedily abandoned. Light wheels, with cast hub and rim and wrought-iron spokes, are made and used in America, but they require great care in manufacture, and are costly. Crucible-steel wheels, cast in one piece with arms, are made in Sheffield. They are light and seem to give good results. Wheels made of American chilled iron are, however, perhaps the best for the purpose. Where lightness is an object, as in the case of one-horse cars, openings are left between the arms. Of the American, the waved-plate wheels, manufactured by the Lobdell Car Wheel Company, give great satisfaction. The difficulty in the manufacture of chilled wheels is, to combine strength in the plates, with sufficient depth of chill in the tread to insure durability. If the plate is flat, it is frequently injuriously affected by the sudden cooling of the outside rim; but the waved plate can give slightly, and is not left in a state of tension.

The average life of chilled cast-iron wheels in America is from sixteen to eighteen months; but in England it is not more than ten to fifteen months, owing to the section of the rail. In America there is no groove, and the flange of the wheel has always plenty of freedom, and can only wear on one side. In England the groove is so narrow that the wheel flange is continually rubbing either on one side or the other. Stones are also caught by and forced into the groove, and the wheels get jerked and chipped. Nothing of the kind can happen with the American rail.

It is not an uncommon theory that wheels on the same axle, having the freedom of independent motion, will operate better than wheels fast on the axle, practically forming a cylinder, and that the free wheels will have special advantages in passing round curves, because the wheel on the outer rail can rotate to accord with the longer length. This theory is fallacious, for the axles are held parallel, and cannot form radii of the curve; therefore the wheels, when passing curves, must necessarily be forced round by a sliding process. If, for illustration, the front axle of an ordinary road carriage be lashed so that it cannot swing round, and the attempt be then made to drive round a street-corner, it will be seen that the looseness of the wheels will not make the operation less impracticable. The loose wheels are therefore useless, and experience shows them to be absolutely detrimental.

An ingenious wheel is used in America, having a second rim or tread on the inside, of a lesser diameter than the other. On coming to facing points this second tread strikes on an inclined plane, the car runs up out of the ordinary groove, and is led over on this elevation into its proper line, when it falls to the same level. By fitting the cars with or without this additional tread, movable points and pointsmen may be entirely dispensed with. The system works well in America, but the elevation in the points would be objectionable in this country.

Brakes.—At first brakes were applied to the treads of car wheels, as on railways; but it was soon seen that the circumstances were different. On railways a deep flange is necessary, and this is not in any way injurious to the rail. On tramways a very slight flange is adequate, and a deep flange would be positively injurious, as it increases the resistance and splits the rail. The tread of the wheel has evidently a tendency to wear more rapidly than the flange, and it is therefore, necessary to wear down the flange proportionately, so as to keep it off the bottom of the groove. This work is best done by chilled iron brakes. The system for using wood for tramway brakes, with the view of saving the wheels, is therefore fallacious, the wheels being saved at the expense of rails and horses.

Timber.—The peculiar construction of cars with short wheel base and great overhang coupled with the immense loads they constantly have to carry, renders it necessary that unusual care be taken in their construction, and in nothing more than in the seasoning of the timber. Oak is the best timber to choose for the substructure and ash for the superstructure.

Endurance.—Cars worked constantly on roads having heavy gradients should last about ten years. It is doubtful if any car in this country will last, even with much renewing, over fifteen years. Some of Messrs. Stephenson's cars have been known to last nearly twenty years in America; in fact, some of that age are certified to be still at work in New York, on "Commodore Vanderbilt's Road."

Size.—The size of the cars may be to some extent ruled by the expected traffic and gradients; but two-horse cars accommodating forty-two passengers are generally useful. Some thought has been expended in arriving at a medium weight, which, while it permits of the car being constructed in a sufficiently substantial manner, is yet not so great as to unreasonably distress the horses. Where steam is used as a motive power, it will probably be prudent to increase the weight and substantiability of the cars. One-horse cars are used freely in America, and to a limited extent in this country. They may be of use where the road is level and the traffic light. The gearing, wheels, etc., of the cars, whether two-horse or one-horse, must be to a great extent similar: so that, in the latter case, the horse has more dead weight to pull.

(To be continued.)

SOME OF THE REASONS WHY GAS CONSUMERS SHOULD NOT FAVOR COMPETITION IN ITS SUPPLY.

We are often asked why our business should be a monopoly. Competition is good; why should it not exist here as in any kind of trade? In regard to many branches of trade there is no absolute limit in regard to the business that they can do, or the amount of consumption. The consumption of gas is limited. There never has been any objection to any man's making his own gas, or to any number of persons uniting together to make gas for themselves, provided their business affects only their own private rights. It is only when certain public rights, *i. e*, to dig up the public streets, and to lay pipes in them, and to use the pipes and the streets for distributing gas, that any objection can be made.

When any right is withdrawn from the public in general, it becomes a monopoly, and remains so, whether the right is granted to one or to six. The right to occupy the same streets with pipes must of necessity be limited because there is not room enough; it is a physical impossibility for everybody to do it. The injury done to streets by excavations for sewers, water and gas pipes, is very great. When you once break the ridge of a paved street it is a broken street ever after, unless it is relaid. The actual interference with the streets will be by two competing companies nearly doubled. The leakage from gas pipes laid in the streets is another important consideration. All know the poisonous effects of gas upon animal and vegetable life, and upon water. From a sanitary point of view the distribution of gas in the public streets is a nuisance, and should be restricted to the actual needs of the gas consumers. The interference of new mains, with those already laid, will increase the leakage, and the escape of gas into the sewers and water-pipes will be increased. If there be two sets of pipes in the same street it will not always be easy to determine where the fault lies, in case of a leak; which company is to make the excavation; Whose leak is it? While the two companies are disputing as to who shall do the digging, immense damage may be done to property, and, perhaps, to life. What means are there of determining; those pipes run through the streets side by side; whose pipe is it that leaks? And if one company digs down to find the leak, and it turns out to be in the pipes of the other company, then the first company will shove the earth back fill up the holes, and the other company must go to work and dig it out again. The annoyance and trouble that would follow, from having two organizations undertake to do the same work, in the same place, are infinite in number.

If you have in any business sufficient capital embarked to do that business, thoroughly and properly, it is perfectly clear that if you put in additional capital the cost of the product must be increased to the consumer. If the facilities of supplying a city are equal to its needs, how can you diminish the price by doubling those facilities. If one pipe laid in a street is sufficient to furnish gas to all the consumers on that street, how will you cheapen the price of gas to those consumers by laying an additional pipe? John Stuart Mill, who is high authority on political economy, writing of competing gas and water companies, says:

"When, in any employment, the regime of independent small producers has either never been possible, or has been suspended, and the system of many workpeople under one management, has become fully established, from that time any further enlargement in the scale of production is generally an unqualified benefit. It is obvious, for example, how great an economy of labor would be obtained if London were supplied by a single gas or water company, instead of the existing plurality. While there are as many as two, this implies double establishments of all sorts, when one only, with a small increase, could probably perform the whole operation equally well; double sets of machinery and works, when the whole of the gas or water required could generally be produced by one set only; even double sets of pipes, if the company did not prevent this needless expense, by agreeing upon a division of the territory. Were there only one establishment, it could make lower charges consistently with obtaining the rate of profit now realized. But would it do so? Even if it did not the community in the aggregate would still be a gainer, since the shareholders are a part of the community, and they would obtain higher profits, while the consumer paid only the same. It is, however, an error to suppose that the prices are even permanently kept down by the competition of these companies. Where competitors are so few, they always end in agreeing not to compete. They may run a race of cheapness to ruin a new candidate, but as soon as he has established his footing, they come to terms with him. When, therefore, a business of real public importance can only be carried on advantageously upon so large a scale as to render the liberty of competition almost illusory, it is an unthrifty dispensation of the public resources that several costly sets of arrangements should be kept up for the purpose of rendering to the community this one service. It is much better to treat it at once as a public function; and if it be not such as the government itself could beneficially undertake, it should be made over entire to the company or association which will perform it on the best terms for the public."

I might rest my argument on this paragraph from J. Stuart Mill, because he has put it in such a concise manner that it settles the question in my mind. But I will quote further, in the same line of argument, from President C. O'Donnel, of the Baltimore Gas-Light Company:

"Competition is a taking word, because in almost all cases it means progress and public good. There are exceptions to this rule as to all rules. There are some things in which competition is impossible. Competing water companies are manifestly impossible. And in proportion as the subject to be competed in approaches a public character, this competition becomes impossible. Competition thrives where the price increases the demand and supply. This fundamental element is wanting in gas supply. One gas pipe in a street will light just as many houses as two pipes. The number of consumers is a fixed quantity, in every street limited by the number of houses, and the competition of rival gas-companies is simply to expend double the necessary capital in doing the same thing.

"If it should actually happen, after some citizens had invested two millions of dollars in extending mains in all the streets, bringing gas to every house, others should expend an equal amount in laying down another set of pipes in all the streets, there is a waste of capital, of two million dollars, in doing something which is already done, and which, when done over again, will supply no more gas, light no house not already lighted. Competing railroads and steam-boats increase the means of locomotion; they enable more people to travel and to travel more frequently; they transport freight lacking means of transportation. Yet, competing railroads and steamboats are not generally practicable between the same points in the same line of direction. Some divergence of route is necessary even in such cases. If one line carries all that offers, and no more is to be had, the result is uniform, and competition exhausts itself or buys out the other.

"In the case of competing gas companies the result is easily seen. Either the new company, after tearing up the streets, and incommoding the public by the nuisance thus made, abandons the field after a brief struggle, or the contest continues, which, while it divides profits, and damages for a while both companies, results either in the ruin of the weaker competitor, or a truce and compact which necessitates a higher price of gas by each company, after the losses of the destructive policy. If the new company succeeds in dividing the business, interest will force the two to agree upon a price, and this price will be sufficient to satisfy the weaker company, and to arrange the supply, while the public has double the nuisance of gas supply and dearer gas. Is establishing a competing company a proper remedy for evils if they exist? Now, I hold it to be demonstrated, both from reason and experience, that competing gas companies in the same district, are not a remedy for anything, but are the worst forms, in every sense in which any given population can be supplied with gas. It is evident, too, that any company that supplies gas must earn on its capital, in the long run, a fair income. If a company does not earn that, it will not do its business well; it will either stop business, or supply poor gas and have poor works, and cease to anticipate the reasonable wants of the city and its citizens, and generally will fail to satisfy the public. You all know that it is only reasonably prosperous companies that, in the long run, do their business well.

"In London and Paris, where competing companies once existed, they have been abolished. In Paris the companies have been consolidated under one management, and the same process is going on in London, which, previous to 1860, had thirteen companies, and as many as four of them competing in the same streets. They were continually tapping one another's pipes. Whenever a leak occurred there was a quarrel between the companies as to whose main the leak was in. This company declined to dig, and another company declined to dig, and there was the greatest possible confusion, and great leakage of gas, throughout the city. They then districted the city, each company keeping its own district until recently, some of the large companies have purchased some of the smaller ones.

"Competing gas companies have been tried in various places in the country, but we defy any one to point out a place where the price has been permanently lowered by competition, while I can point out several places where the price of gas is higher than it would have been had it not been for competition. If a gas company occupying a district does not do its work well, it should be made to do its work well. There are now in operation some very efficient checks against overcharging by gas companies, and other remedies can easily be provided by legislation, if you become satisfied that an intolerable grievance exists that must be removed. The first is the competition of kerosene and other oils; the second is the force of public opinion. If these prove insufficient there are still other methods of correcting the supposed evil. If gas consumers would investigate the apparatus for measuring their gas, and the most approved methods of consuming it, in order to get a maximum of light from it, there would be less complaint of overcharging and poor quality.

"I believe that the gas companies mean to treat the community and their consumers fairly, and to furnish gas as cheaply as it can be done, with reasonably prudent management of the property invested in the business.—*American Gas-Light Journal.*

CORRESPONDENCE.

LOCKPORT, N. Y., *October 31, 1877.*

Editor ENGINEERING NEWS:

Sir.—For reply to various questions asked in No. 43 of ENGINEERING NEWS, by Mr. W. M. Johnson, C. E., I would state that I have labored frequently under the same difficulties as your correspondent, and given considerable attention to this matter. I will give my views on the subject in question based upon good legal advice, which I had occasion to take. But as a number of the questions asked require consideration rather of a good lawyer than a civil engineer, I would advise your correspondent to consult a lawyer in good standing, as there may be a vast difference in the law of the State of New York and the State of Texas. My experience is limited to various large villages and small cities in this State.

As to the first question: What is the duty of the city in regard to taking care of the rainfall when the natural drainage is over and through private property? I should say that after a new street is duly laid out and accepted as a public highway, which must be done according to law whatever the law in that respect may be in your locality, so that there can be no possible dispute on the question, whether it is a public street or not, the city or corporation must take care of the water falling on the street, and has a perfect right to empty such water on private property, provided the water course in its state of nature went through said property. No private individual has a right to obstruct a natural water course, but if the city throws a greater amount of water on a private lot by grading a street, the property owner is entitled to such damages as he may sustain by such action of the city; but it must be *clearly* shown that he does sustain actual damages if the amount of water after grading a street is ten times what it was before the grading, and still if the property owner cannot *clearly* show that he is damaged by it he will not be entitled to any compensation; in no case whatever can he obstruct a natural water course without making himself liable. But the city has no right to create new water courses emptying on private property. It has a right, however

to change water courses on its streets, and has a perfect right to lead it to some point where a creek or stream crosses a street. For instance a street a mile long is intersected by one creek and four water courses so that in its natural state water is discharged on five different places, all emptying on private lots; by grading the street all the water is taken to the creek; this a city has a right to do. But if the city empties now so much more water into the creek that it damages private property the city of course is liable for such damages. I, however, have seldom if ever come across a case where damages could be shown because as a rule, creeks in times of freshets will damage property whether there is a little more or less water discharged into the creek. According to the laws of the State of New York a city can create a *new* water course through private property, but before doing so it must require title to it in the same manner as railroad corporations require title over land where they lay their track.

Second question: Can the property owner fill up his lot and throw water on his neighbor, or in the street, or must the water way be kept open as it was, and is the city compelled to confine the water way to its original bounds and see that it does not damage private property?

A property owner can fill up his lot and thereby throw water on the street without question; he can also throw water on his neighbor provided that he does not damage him. The fundamental law which governs all such cases is that of damages. For instance the Erie canal discharges its waste water into numerous creeks; at times of great freshets a large amount of damage is done all along the line of said canal by overflowing farming land, destroying or injuring mill dams &c. &c. There are a number of suits brought yearly against the State of New York for such damages, but as far as I know out of one hundred cases not more than five are allowed, for the reason that it can not be clearly shown that a freshet without the waste water of the Erie canal could not have done the same amount of damages, although I personally have seen that in a number of cases the amount of water discharged through the waste gates of the canal is fully equal to the amount of water caused by ordinary freshets. States have no more rights than individuals in such matters. No private individual has a right to obstruct a natural water way. The city is not compelled to confine the water way to its original bounds provided it damages no one by changing the same. The city does not need to see that private property is not damaged if the damage is not caused by water discharged from the street proper.

Third question: Must the city at its own expense wall in and pave all the natural drains in its limits? or cannot the property owner be compelled to leave the water way open and wall it in and pave it at his own expense?

The property owner can be compelled to leave the water way open but he cannot be compelled to wall it in and pave it at his own expense. If the natural soil is such that it requires walling in and paving, it must be done at the expense of the city. In our incorporated cities it would be done by local taxation, that is, a tax levied on all lands which shed toward the water course to be walled in and paved according to the benefits received. In our incorporated village it is done out of the general fund. All the above statements refer to rain water only; different laws governing the construction of sewers and taking care of sewage matter.

I cannot refer to any authority or court decision, but am certain that your correspondent will not err if he clearly looks into the question of damages; the fundamental law for all civilized nations being about the same, that the individual rights of land owners are sacred and must not be violated, and if violated a full compensation must be made for all damages sustained.

Perhaps I have been somewhat too lengthy, and would encroach too much upon the space of your valuable paper, but I hope I have expressed myself clearly enough, so that you can give a condensed extract if you see fit. I have had considerable experience in regard to taking care of sewerage matter, polluting streams, &c., but there being no occasion for such questions on the side of your correspondent, I will not occupy any more of your space, especially as this matter is not so well defined and more complicated.

Yours truly,

JULIUS FREHSER.

ENGINEER'S OFFICE,
HOBOKEN, N. J., *Oct. 30, 1877.*

EDITOR ENGINEERING NEWS:

Sir.—In your issue of the 27th inst., a communication appeared signed W. M. Johnson, City Engineer of Dallas, Texas, asking for information as to individual rights affecting the natural drainage of cities.

We have had considerable trouble as to that question in this locality, but the following conclusions have been finally established:

1st. That no individual can close or divert a natural watercourse. If an owner wishes to improve his property he must first wall up and protect the watercourse thereon.

2d. That no individual or corporation can pollute a natural watercourse without thereby becoming responsible for damages.

3d. Pollution consists in doing anything to a stream that will injuriously affect the color, taste or smell of the water.

4th. It is held, however, that mere surface water from rain falling or any drainage area can be artificially drained into the natural watercourse of that drainage area and that this does not constitute pollution as aforesaid.

5th. In case a city finds it necessary to use a stream for carrying of refuse matter or sewage, the city must condemn or agree with the owner of the land on which the watercourse exists as to the value of the right of way. This we consider is about one half the value of the property.

It is then the duty of the city to wall in, pave or build whatever structure may be necessary and assess the property benefitted its proportion of the cost of the improvement.

Respectfully submitted,

SPIELMANN & BRUSH.

MILWAUKEE, *November 1, 1877.*

EDITOR ENGINEERING NEWS:

Sir.—Upon your invitation for answers to the questions asked by your correspondent of Dallas, Texas, in your last number I will state what is the rule in our city in such cases.

If the water way is a natural watercourse, and if there is no public sewer near enough to permit the property likely to be damaged by the backing up of water, to drain into, the property owner has no right to fill up the same without first constructing a culvert or sewer along such watercourse at his own expense, and the city has a right to run the surface water of the adjoining and cross streets into the same; if however it is not a watercourse, but only a ravine or hollow, the property owner has a right to fill up the same for the purpose of improvement, without making any provision for surface water drainage except to take care of such surface water as may accumulate by rain on his own property.

As the ground upon which our city is built, was originally very rough and broken up by numerous water courses and deep ravines, these questions have frequently come up for discussion and decision.

We have had a score of cases here where such water courses have been filled up by the property holders to a level with the streets for eight and ten squares in length, but never without first constructing a drain large enough to carry off the accumulating water.

One of our last cases is one where a natural water course runs through a large private park. All surface drainage from neighboring streets has been led into it, and now a public sewer of 4 feet diameter is being constructed through one of the adjoining streets which is to empty into this watercourse. The owners of the park objected to the sewage flow, but it has been decided that the only remedy left them is to continue the sewer through their park and make the discharge below the same.

As to *ravines* and *hollows*, in a decision given by the Supreme court of this State in the January term, 1871 in a similar case against the city of Hudson, the following expressions are found. "The doctrine of the civil law is, that the owner of upper or dominant estate has a natural easement or servitude in the lower or servient owner, as in a state of nature; and that such natural flow or passage of the water cannot be interrupted or prevented by the servient owner, to the detriment or injury of the estate of the dominant or any other proprietor." Such I believe is the rule in the States of Pennsylvania, Iowa, Illinois, and perhaps Missouri and Ohio. Further: "The doctrine of the common law is, that there exists no such natural easement or servitude in favor of the owner of the superior or higher ground or fields as to mere surface water or such as falls or accumulates by rain or the melting of snow; and that the proprietor of the inferior or lower tenement or estate, if he chooses, can lawfully obstruct or hinder the natural flow of such water thereon, without liability for injuries ensuing from such obstructions or diversion." This is the rule in England, in Massachusetts, New York, Connecticut, Vermont, New Jersey, New Hampshire and Wisconsin. Therefore "*unless* the ravine or hollow in question had the properties of and constituted what is known in law as a watercourse" the parties are not holden to any damage that may arise by the filling up of such ravine. In the same decision is also found "In a watercourse there must be a stream *usually* flowing in a particular direction, though it need not flow continually. It may sometimes be dry. It must flow in a definite channel, having a bed, sides or banks, and usually discharge itself into some other stream or body of water. It must be something more than a mere surface drainage over the entire face of a tract of land occasioned by unusual freshets or other extraordinary causes. It does not include the water flowing in the hollows or ravines in land, which is the mere surface water from rain or melting snow, but which at other times are destitute of water. Such hollows or ravines are not in legal contemplation watercourses."

I believe this will partly cover the similar case of your correspondent, although court decisions can not be accepted as a rule in every instance, as the natural position and circumstances that may surround a case will greatly alter its requirements, which must be met by the engineer.

Yours truly,

G. H. BEUZENBERG,
Ass't. City Engineer.

THE BOUNDARY SURVEY.

In June last the engineer corps selected by the joint commission of Pennsylvania and New York to resurvey the boundary line between these two States began their labors at the stone set up on an island in the Delaware as the northeast corner of Pennsylvania and the southwest corner of New York by Rittenhouse and De Witt in 1786. They have surveyed the route to the 119th mile post, within three miles of the Allegany County line, where a post has been set and the work suspended for the season. The engineers reached at this spot the beginning of the high mountain ridge which is the water shed of the Susquehanna on this side and of the Genesee on the other. While the distance surveyed is about half of the whole route, the labor in the remaining distance will be greater and more difficult in accomplishing, owing to the intervening high mountain chains, large streams, and rough, wild country. The new survey has thus far varied but little from the old boundary line, and most of the old mile-stones have been found. Those discovered in the early part of the work were more carefully set and protected better than the ones found latterly. In locating these old landmarks the engineers received great aid from people living along the line, which, together with the fine weather they have had ever since the work commenced, has enabled them to make such rapid progress. The slight variation the new survey makes from the old shows that most remarkable skill was possessed by the original surveyors, who, ninety years ago had few of the fine scientific aids in their work that the engineer of today uses in his work. Since the party left Waverly, or thereabout, they have used the compass but little, using signals from one to another from the summits of the mountains.

The most striking of the changes made by the new line is the dividing of a large part of the village of Waverly, placing a considerable number of the residents in an entirely different State and county from those they have already been supposed to dwell in, the locating of Lawrenceville, Tioga County, Pa., in the county of Chemung, N. Y., and the transferring of Ceres N. Y., to the State of Pennsylvania. The new boundary has been accepted by the local authorities of Waverly, and has been permanently fixed. The work thus far has been carried on with great economy in expenditure, the preliminary appropriation not having been exhausted. The work will be resumed early in the spring.—*The World.*

ARCHES;

CONSIDERED GRAPHICALLY.

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(*Continued from page 292.*)

If the arch is less than a semicircle, § 91 gives

$$\Sigma D E^2 = r^2 (\beta + 2\beta\cos^2\beta - 3\sin\beta\cos\beta),$$

and $c = r\sin\beta$; therefore, substituting, we obtain

$$H_t = \pm \frac{2EIte\sin\beta}{r^2(\beta + 2\beta\cos^2\beta - 3\sin\beta\cos\beta)}, \qquad (30.)$$

and the bending moment at the crown will be

$$M\text{ (at crown)} = \frac{2EIte\sin\beta(1-\cos\beta)}{r(\beta + 2\beta\cos^2\beta - 3\sin\beta\cos\beta)}.$$

If a load of the proper amount and distribution were imposed on the rib to place it entirely in equilibrium and cause it to exert against the abutments the desired value of H due to temperature, such a load would supply the amount of shear at each section which was needed, and when the load is absent, the bracing must supply such shear. The line *k e c e' p* of the shear diagram of Fig. 23 will therefore limit the vertical shear ordinates for the web under changes of temperature, provided c-3 is the amount of H_t, and *w c' c e' r* will very readily give the shear on any normal section of the web. A reference to §§ 86 and 97 will aid the reader in recalling these points.

100. When the circular rib is fixed at the ends, we apply the three equations of condition which were developed in §§ 23 and 24, and were applied to the parabolic rib in § 66, summing up the ordinates, however, along the arch, as has just been done in the preceding case, in place of the horizontal line. When the arch is a complete semicircle, or, as it is often called, a complete arch, as distinguished from a segmental one, the values of y_0, y_1 and y_2 may be obtained by a device similar to the one employed in § 90. The equation to satisfy the first condition is easily derived, but the two others present more difficulty; it is therefore not expedient to take up the semicircle as a special case, but rather to work out the general equations and then make the necessary substitutions for the semicircle.

We have then, from § 66, our first condition, that

$$\Sigma D E^2 = \Sigma D F . D E. \qquad (9.)$$

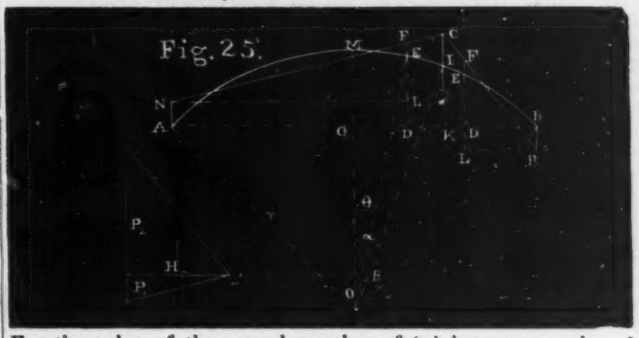
The notation corresponds with that just used, as seen in Fig. 25, except that we now have $AN = y_1$, $CK = y_0$ and $BR = y_2$. $MOB = MOA = \beta$, $MOI = \alpha$, and MOE, to any point E, $= \theta$. Referring to § 91, we see that

$$\Sigma D E^2 = r^2 (\beta + 2\beta\cos^2\beta - 3\sin\beta\cos\beta).$$

Many of the following expressions also are similar to those of § 91, while a notice of the relation between y_1 and y_2 will, in a measure, prevent the ensuing work from seeming so involved as it otherwise may appear. It will be seen that $DF = DL + LF = y_1$ (or y_2) $+ LF$, and that, therefore, in place of the values of the section just referred to, we shall write

$$DF = y_1 + \frac{\sin\beta + \sin\theta}{\sin\beta + \sin\alpha}(y_0 - y_1), \text{ on the left of K;}$$

$$DF = y_2 + \frac{\sin\beta - \sin\theta}{\sin\beta - \sin\alpha}(y_0 - y_2), \text{ on the right of K.}$$



For the value of the second member of (9.) between α and $-\beta$ we have then

$$r^2 \int_{-\beta}^{\alpha} [y_1(\cos\theta - \cos\beta) + \frac{y_0 - y_1}{\sin\beta + \sin\alpha}(\sin\beta\cos\theta + \sin\theta\cos\theta - [\sin\beta\cos\beta - \cos\beta\sin\theta)]\, d\theta$$

$$= r^2 [y_1(\sin\alpha - \alpha\cos\beta + \sin\beta - \beta\cos\beta) + \frac{y_0 - y_1}{\sin\beta + \sin\alpha}(\sin\alpha\sin\beta - \tfrac{1}{2}\cos^2\alpha - \alpha\sin\beta\cos\beta + \cos\alpha\cos\beta + \sin^2\beta - \tfrac{1}{2}\cos^2\beta - \beta\sin\beta\cos\beta)].$$

Likewise for the value of the second member between α and $+\beta$ we get

$$r^2 \int_{\alpha}^{\beta} [y_2(\cos\theta - \cos\beta) + \frac{y_0 - y_2}{\sin\beta - \sin\alpha}(\sin\beta\cos\theta - \sin\theta\cos\theta - \sin\beta\cos\beta + \cos\beta\sin\theta)]\, d\theta$$

$$= r^2 [y_2(\sin\beta - \beta\cos\beta - \sin\alpha + \alpha\cos\beta) + \frac{y_0 - y_2}{\sin\beta - \sin\alpha}(\sin^2\beta - \tfrac{1}{2}\cos^2\beta - \beta\sin\beta\cos\beta - \sin\alpha\sin\beta - \tfrac{1}{2}\cos^2\alpha + \alpha\sin\beta\cos\beta + \cos\alpha\cos\beta)].$$

(*To be continued.*)

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

WALTER KATTE, C. E., formerly treasurer of the St. L., K. City & N. R. R., St. Louis, Mo., has been appointed Chief Engineer of the New York Elevated R. R. Co., New York City.

BRIDGES.

Contracts have been closed by the Keystone Bridge Company, of Pittsburgh and Philadelphia, for the construction of one mile of the Gilbert Elevated Railway in New York City; an iron bridg of 13 spans over the Monongahela river, at Port Ferry, for the Pennsylvania R. R. Company, and a double-track iron bridge of 4 fixed spans and one draw span on the New Jersey Division, at Brunswick, for the same company. The Keystone has several other important contracts on hand for bridges in the Eastern and Western States.

The Canton Iron Bridge Co., have just completed an iron bridge across Straight river at Faribault, Minn. The bridge is a single span of 140 feet, 18 feet clear of roadway, and sidewalks 5 feet in the clear on each side, roadway planked with 2½ inch oak plank, sidewalks with 2 inch pine. The bridge weighs 32 tons without the planking and floor beams and is capable of sustaining a rolling weight of 2000 pounds per lineal foot with a factor of 4. Cost of bridge including planking and painting, $3,980.

GAS AND WATER-WORKS.

In Guelph, Ont., the price of gas is $3 per thousand cubic feet.

A. L. Dobbs, manager of the Ripon, Wisconsin, gas works contemplates having the machinery in readiness to let on the gas in a day or two.

City engineer Chesbrough of Chicago, said lately that the water-supply of the city, averaged now about 50,000,000 of gallons per day, or 100 gallons per day for each man, woman and child in the city, estimating the population at 500,000 souls. During the month of August the daily consumption was 60,000,000 of gallons or 120 gallons per day for each soul.

The amount of stock necessary to insure the building of water works in the city of Keokuk, Ia., is raised, and work will be commenced at once chiseling, putting in the channel and building the foundation. It is thought the works will be in operation by the middle of May. They are to cost $100,000 and will be of the most approved pattern, Clough & Co., of Chillicothe, Ohio, are the contractors.

The Holly manufacturing Co., of Lockport, N. Y., has bought of Dennis Long and Co., of Louisville Ky., 2,000 tons of Water pipe for the new water works to be built at Burlington, Iowa. The Little Rock, Ark., Water company yesterday closed a contract with Long and company, for the construction of the entire water works at Little Rock. The price for the works completed is $110,000. Both contracts were awarded in competition with the other pipe works of the country.

RAILROADS.

It is promised that cars will be running through to Bridgeport, on the Tuscarwas Valley road, Va., by the first of next July.

One hundred thousand dollars having been guaranteed, the construction and completion of the Miami Valley R. R., Ohio, is now regarded as a certainty.

The citizens of Shreveport, La., and between that city and Monroe, are taking action towards the building of a railroad between those two points. The road is to be called the Red River & Mississippi R. R. A large amount has been subscribed and committees appointed to solicit more subscriptions in the parishes through which the road will run.

A movement is on foot to make Port Royal, South Carolina, the South Eastern port of shipment to Europe direct. Some prominent men are investigating the prospects.

A narrow-gauge road is proposed from McConnelsville to the Perry county coal fields, O. This would also give the citizens of that place a connection with the outside world, via Zanesville, Newark and Cincinnati.

Toledo people are making an effort to have the Ann Arbor and Toledo railroad opened. A large portion of the grading has been completed for some time, awaiting the propitious moment to finish the work. It will enter Toledo in the vicinity of the Columbus and Toledo depot, and will, when completed, be of immense advantage to the latter road, as it opens up a new section of Michigan to the coal traffic.

A meeting of the directors and stockholders of the Cincinnati and Eastern road was held at Sardinia, O., lately, and it was agreed to render all the aid possible for the construct on of the Hillsboro and Sardinia narrow gauge road, for the building of which all necessary subscriptions have been secured, and work will commence immediately. This road will prove an important feeder to the Cincinnati and Eastern road.

Work on the Pittsburgh and Lake Erie road is being pushed along rapidly. The grading from Youngstown to Beaver Falls will be finished within three months, and it is expected that trains will be running to and from these places by February. The line will be an unbroken route from Pittsburgh to Cleveland; the rails will be steel; the bridges and culverts iron and stone, and the grade is being made with a view to putting down a double track.

A special cable despatch to the Toronto *Globe* says: "The Grand Trunk R. R. report shows a reduction of

$69,000 in running expenses after paying all preference charges. This leaves a balance of $751,000 to be added to the capital account. The president announced a a full report of the negotiations with Mr. Childers at the meeting. He believes that an understanding has been established between the various presidents which will result favorably to the proprietors."

Two railroads in Western North Carolina are being constructed mainly with convict labor. One of these will run from Tyron, at the gates of the Green River Mountains to Hendersonville and Asheville, and thence along the valley of the French Broad river to Morristown, Tenn. The other will lead from Asheville through the wonderful gap to Old Fort and Salisbury. The corporations pay the State ten cents a day for every convict, and employ at least 700 men. Stockades are built, and strong guards are stationed where the gangs are at work, but the expense per man does not exceed sixty cents a day, so that the labor is cheap. These roads, if they are ever completed, will open to the traveling public one of the most beautiful sections in America. To reach Black Mountain, which is the highest range east of the Rocky Mountains, one must now ride by stage to Asheville, go horseback twenty miles to the foot of Mitchell's Peak, and after a night's rest in a wretched rookery, make the ascent by a treacherous bridle-path. It is a jaunt of three days, and one which ladies can scarcely venture to make.

A contract for the completion of the Cumberland & Ohio R. R. has been closed with the Nashville, Chattanooga & St. Louis R. R., which company is to endorse the first mortgage bonds and to lease the completed road for twenty-five years. The road will connect Louisville with Nashville, and Cincinnati with Nashville, and its original extension to Madison, Indiana may also interest the city of Chicago. Another road is also contemplated, called the Nashville and Tuskaloosa R. R. It will start from Bon Aqua station, forty miles from Nashville on the Nashville & Northwestern R. R., and will pass through Centreville, Lawrenceburgh, Florence, Ala., to Tuskaloosa, Ala. It will penetrate the centre of the celebrated Tennessee brown hematite iron region, and will pass through the heart of the Warrior coal field of Alabama. It will be a valuable feeder of the Nashville, Chattanooga and St. Louis Railway, and this Company has also agreed to endorse the first mortgage bonds. Both the Cumberland & Ohio and Nashville & Tuskaloosa Railroads will be of 3 feet gauge for reasons of extreme economy, imperiously *demanded* by the circumstances.

The London *Daily News* says: Operations connected with the submarine tunnel beneath the British Channel have already been commenced on the other side of the Channel, several pits having been sunk to the depth of about one hundred and ten yards. At the same time the French and English committees have definitely drawn up the conditions of working for the route. The property of the tunnel is to be divided in half by the length—that is to say, each company will possess half of the line, reckoning the distance from coast to coast at low tide. Each company will cover the expense of its portion. The general work of excavation will be done, on the one hand by the Great Northern of France, and on the other by the Chatham and South Eastern companies, the two latter having each a direct route from London to Dover. All the materials of the French and English lines will pass through the tunnel in order to prevent unnecessary expenses and delay of transhipment, as in England and in France railway companies use each other's lines, and goods can pass from one line to another without changing vans. It is understood that an arrangement will be established for a similar exchange of lines between all the English and Continental railway companies when the tunnel is completed. The tunnel will belong to its founders. At the expiration of thirty years the two Governments will be able to take possession of the tunnel on certain conditions.

There is every prospect of the early completion of the Cincinnati Southern R. R. from Somerset to Chattanooga.

CONTRACTORS.

Hunter, Murray & Cleveland, of St. Catharines, Ont., have been awarded sections 27 and 35 of the Welland Canal enlargement, which includes the building of the new aqueduct across the Chippewa river, at Welland, and the work connected with the enlargement at the entrance to Lake Erie at Port Colborne. Work has been commenced. It is expected to require four years to complete the work.

The Louisiana State Board of Engineers met lately at the Executive office. Present—His Excellency Governor Nicholls, ex-officio president, and Messrs. Harrod and Hardee. At noon there were present some fifteen or twenty contractors, and at that hour the opening of the bids was commenced for the Scott and Colomb levee, in the parish of Pointe Coupee, the Schlabre levee, and the Spangenberg levee, with the following results:

SCOTT AND COLOMB.		SCHLABRE.	
Jas. Fogarty	29	Jeremiah Foley	19½
J. R. Fitzgerald	35	I. Irwin	22
P. G. Conway	39	Jas. Fogarty	19½
P. Ryan	26	J. R. Fitzgerald	22
Andrew Downey	26¼	P. G. Conway	23
Wm. Ayres	23¼	SPANGENBERG.	
		I. Irwin	21
		Jas. Fogarty	20
		J. Chary	22

The lowest bid for the first named levee having been made by Mr. Ayres, he was awarded the contract for the construction of that work. Mr. Foley was awarded the contract for the Schlabre work, and Mr. Irwin for the last one named. The board then decided that hereafter all transfers of contracts should be made in the form of an affidavit, as has been required previously. Whereupon the board adjourned.

MINING.

A bed of copperas has been found beneath the iron ore at the Katahdin Iron Works, Penobscott county.

A new slate quarry has been opened in Brownville, Piscataquis county, and a company under the name of the Thomas Hill Slate Company has been organized to work it.

The mining excitement seems to be spreading in New Hampshire. The Gardner Mountain Mining Company, with $600,000 capital, has been formed to work a copper mine at Littleton, and one with $1,000,000 is to be formed to work the White Ledge Gold Mine at Sandwich, whose citizens are all dreaming of fabulous wealth in their farms.

The Ashland *Review* (Hanging Rock region of Kentucky) says: "Native ores of this section average 31.94 per cent., and it requires an average of 179 bushels of charcoal to the ton of iron. The richest ore (Kenton) reaching 32.3, the poorest (Raccoon) 30.4; the most coal, 229 bushels at Buffalo and the least, 141 at Buena Vista. (Buffalo running cold blast.) A cord of wood makes 40 bushels of charcoal, our forests average 35 cords to the acre, furnaces vary from 5000 to 15,000 cords per annum, according to length of blast, so that our 8 active charcoal furnaces clear off about 2,600 acres of land per year. These *data* come from the Geological survey of Ky., for 1876."

MISCELLANEOUS.

At the meeting of the Board of Examiners of Land Surveyors for Ontario, held at the department of Crown Lands some time since, the following gentlemen passed a successful examination and were duly admitted and sworn in as land surveyors for Ontario:—E. G. Barrow and G. H. Beasley, of Hamilton, and R. H. Coleman and C. A. Shaw, of Toronto. Several candidates were rejected for want of knowledge of the Survey Act, astronomy, division of land, and method of preparing descriptions of property.

The Springfield (Mass.) *Republican* says: Europe is getting instructive reports from the very capable men who were sent over here to the Philadelphia Exhibition. Herr Hoefer, one of the Austrian Commissioners, has produced a valuable pamphlet on the petroleum production and trade of the United States. The most interesting thing about it to us is, that Hoefer's investigations lead him directly to the conclusions which the *Republican* has been driven to namely: that we are rapidly exhausting the Pennsylvania reservoirs of petroleum. The northern oil district was pumped dry, says Hoefer, in 10 years, and wells generally cease to yield after three years. The time may not be far distant when, instead of exporting 260,000,000 gallons of illuminating oil, as we did last year, we shall have to import it, perhaps from the Black Sea region, where Mukhtar and Melikoff are having their tussle.

The Belt railroad, encircling Indianapolis, Indiana, was opened for business Thursday Nov. 1.

Traffic on the Ohio canal has been quite brisk for a few weeks past, preparatory for finishing up for the season.

Bishop John Sharp has taken the contract for an improvement on the Weber river at Ogden, the Union Pacific and Central Pacific companies joining with our local railroads in the work and placing it under the bishop's direction. The river, a little distance above the Utah Central bridge, takes a shoot direct for the eastern bank, threatening to burst over the bounds and flood the buildings belonging to the U. P. company. A wing dam will be constructed and measures taken to turn the stream towards the west bank and into its proper channel, so as to do no damage on either side. The work is in good hands, and will proceed with that promptness and efficiency that usually mark the contractor's management.

We quote from the Nashville (Tenn.,) *American*: "One of the most important works in the country is that of the construction of the new canal around the Muscle Shoals, by which an immense territory will have a ready outlet by water. It will be fourteen miles long, having eight locks. Three locks, about 400 feet in length each, having been completed. The canal is 60 feet wide at the bottom, and 80 feet wide at the top, towards which it slants. Each lock costs $175,000. An appropriation of about $600,000 will be necessary to complete it. Should the money be appropriated at the next session of Congress, it is believed the work could be consummated within the next three years. The bed of the old canal is being utilized and the contractor now has between 500 and 600 laborers at work at the shoals. This canal completed, and a water connection thus made between the Tennessee and Coosa rivers, the whole Mississippi Valley and the South would be connected by water, vastly cheapening the transportation of the richest valley on the continent."

In his report, the United States Chief of Engineers has the following concerning the improvement of Detroit River, Michigan: This work was begun in the latter part of September, 1876, at the shallowest portion of the Lime Kilns Crossing, directly in front of the Canada Southern Railroad dock, and 2,632 cubic yards of rock excavated, when the funds were exhausted. The work which has been done leaves this spot in a more dangerous condition than it was before, because it has, of course, left high rock projections in the edges of the excavation. The officer in charge believes that $200,000 additional will give a channel 300 feet wide and 20 feet deep across this dangerous shoal, if the money is appropriated at one time, and he recommends that this be done.

July 1, 1876, amount available	$ 21,446.10
July 1, 1877, amount expended during fiscal year	21,446.10
Amount (estimated) required for completion of existing project	200,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1879	200 000.00

We clip the following from correspondence to the *Wheeling Intelligencer* on the Ohio River Improvement Commission and its work:—"The Commission have concluded as soon as possible to place one of the contemplated adjustable dams in the Ohio river five miles below Pittsburg. The purchase of the ground is about concluded on each side of the river for the purpose of placing this lock and dam, and there is now placed by Congress at the disposal of Col W. E. Merrill the United State Engineer in charge of river improvements, one hundred thousand dollars for this purpose, and it is the intention of the Commission to urge an additional appropriation by Congress the coming session for the completion of the work. This will be the first lock and dam built in this country upon the plan and principle now recommended by the U. S. Engineer and adopted by the commission. This plan is not new; it has been in practical operation on similar rivers in France and Germany, and has proved a success. Col. Merrill does not propose this as a plan of his own. He does not consider it an experiment: he proposes to add nothing only where it may be necessary to meet the wants of the Ohio river. The first lock and dam will prove its utility, and if the workings are entirely satisfactory the Commission will then urge the carrying out of this great and important improvement upon the Ohio river down at least to Louisville.

[Special Correspondence.]

CLEVELAND.

The night trip by boat from Detroit gives one an agreeable rest and brings him into Cleveland at 7 A. M., in good time and in proper appetite for a square meal. Nine hours does not give a great opportunity to look about, but one soon learns that there is a lower Cleveland down on the Lake front and on the river bottoms, covered with heavy commercial buildings, manufacturing establishments of diverse kinds and on an extensive scale, lumber yards and coal docks, etc. We pass mainly out of this region as we climb the "Hill" to our hotel in the vicinity of the City Hall, and if a person could inspect this portion only, and then take a drive out on Euclid Avenue, one of the finest streets in the world, he would undoubtedly leave Cleveland impressed with its great beauty and wealth. But Cleveland has only one finest avenue and to that every primitive Clevelander refers the stranger in true provincial spirit, although, methinks, there are many other streets on which most American engineers would be happy to own a house and lot even at the present time.

Cleveland is somewhat larger than Detroit, although on the whole not so fine a city. She is interested as greatly in Lake commerce as any other inland port. The Cuyahoga has proved quite inadequate to the needs of commerce, and the Government Engineers have already recommended plans for an outer harbor at an estimated cost of several million dollars. There seems to be less complaint here of the stagnation of Lake commerce than in other Lake cities. We notice in this morning's paper that the contracts for three first-class propellers, to be built this winter, are already let, while other vessels of various types are mentioned.

Cleveland is also a railway centre having important arterial lines to all the great cities both East and West. This, with her location on the Lakes makes her an important shipping and transfer point. Aside from her commercial advantages, we must also note her monopoly of the oil refining business, and to the novice the arrangement of side-tracks and piping for discharging the oil cars and conveying the oil to the storage tanks thickly scattered about, presents an interesting spectacle. She has also great iron works, among which may be noted the Cleveland Rolling Mill, of which A. B. Stone is President. This mill has for a long time supplied the American Bridge Company of Chicago with most of its iron. But to describe all of interest to the engineer in Cleveland would merit several articles.

We shall only refer to the Cleveland Water Works as one of the most difficult pieces of water work engineering yet executed in this country. The tunnel extending a mile and a half under the lake, although built with the first Chicago tunnel as a precedent, met with many peculiar and aggravating difficulties. An account of its construction along with a description of the engines, reservoirs, etc., we hope to present at a future time.

The only extensive work of interest to the civil engineer under construction at present is the Cleveland Viaduct, one of the largest pieces of masonry in this country.

The entire length of the improvement from the foot of Superior street to the foot of Pearl street is 3,300′. Commencing at the foot of Superior street there are 150′ of retaining walls and three 50′ spans of continuous plate girder,—descending toward the river 8″ per 100′;—two 145′ spans and one 160′ span Pratt iron truss brings us the draw. The pivot span is 332′ in length, with 140′ openings, reaching to the masonwork proper on the west side. This masonwork is 1,300′ in length and consists in order of eight 83′ arches, one 97½′ arch, 240′ retaining walls, and a second 97½′ arch over the A. & G. W. R. R., thence retaining walls to the foot of Pearl street; all the arches are segmental.

The radius of the 83′ arches is 42½′, and of the 97½′ arches, 59¼′; the rise above springings is 33½′. The hight of the roadway above the river is 68′ and the entire width of the masonwork over all is 64′, providing two sidewalks of 11′ each and a roadway of 42′ on which two street-car tracks will be placed. There are two points of considerable curvature in the structure one just beyond the river by the arches and the other in the long retaining wall near the A. & G. W. R. R. Instead of building skew arches at the carved portion it was deemed best to build the abutments on radial lines making them very thick on the outer circumference.

The structure was originally designed by C. H. Strong of Cleveland, the then City Engineer, and building commenced three years ago this autumn. The present City Engineer B. F. Morse, having been largely engaged in masonry construction previously, was appointed City Engineer, two and a half years since, and after making some slight alterations in the plans, the work proceeded under his direction. The mason work is well advanced and the viaduct will be opened for traffic in about a year. The entire cost of the viaduct including right of way, damages, everything complete, will be about $2,150,000, as near as can now be estimated. The actual expense of the structure itself will be about $1,500,000.

The stone used is the well known Berea sand stone, quarried within fifteen miles of the city. The brother of Mr. E. W. Ensign, who recently died, will finish his contract for the masonry of the west side, and Sherman & Flagler have the contract for the masonry on the east side. The iron work is not yet let.

After gathering these facts from the courteous engineer and inspecting the plans, we paid a visit to the structure itself. Its appearance when completed will be quite imposing, and it will certainly be an admirable structure both in an engineering point of view and to furnish Euclid avenue a companion string for the Cleveland fiddle. Without the slightest reflection on Mr. Strong we think that if the structure were to be designed in the light of the past experience many alterations could be made which would add to its beauty, as well as constructions adopted which would materially lessen the cost.

The object of the structure is to unite in closer social and business bonds East and West Cleveland, now separated by an uninviting river, and a flat covered with lumber, oil and manufacturing interests, and only connected by roundabout hilly streets through uninteresting districts.

Probably if the structure had not been begun previous to the great financial panic, its construction would have been abandoned to a more favorable opportunity or else undertaken in the form of an iron viaduct at half or two-thirds the cost. There are many who would say that capital was yet too dear in this country to sink in the construction of such costly structures, and that the Cleveland Viaduct and St. Louis Bridge are more consonant with European thought and 3-per cent loans than with that bottom plank of American Engineering,—the very most for the very least money. Withal Cleveland will be proud of her viaduct, and that is two-thirds of a justification.

We expect from the pen of Mr. Morse, at a future day, an analytical and descriptive article on this great work in all its essential features.

In our call upon Mr. L. H. Clarke, the chief engineer of the Lake Shore & Michigan Southern Railway, formerly of the Illinois Central Railway, we learned that the timber viaduct spanning Ashtabula Creek, in place of the bridge that fell in December last, is now being replaced by a substantial iron structure over which the most timid need not fear to ride. Ashtabula undoubtedly did indirect good to this country; it sent an electric thrill through the profession of engineers everywhere, causing each individual to examine anew old structures, and reflect carefully over plans and calculations. The scene of that night, followed by the death of so able a man as Charles Collins, the chief engineer, will have a healthful effect in preventing like accidents on all railways, the Lake Shore in particular, until this generation of engineers passes away, or are discharged, as they seem to be quite rapidly at present. Probably no safer road exists in the United States than the Lake Shore and Michigan Southern. If they heed the lesson well, it will so continue.

We also paid a visit to Mr. Charles J. Latimer, chief engineer of the Atlantic & Great Western Railway. In his genial way he had several new and interesting facts to communicate in regard to the "divining rod." We were also much pleased with a colored chart on which were represented graphically all the various items of expenditures and earnings for the varied service of the A. & G. W. Ry. Such a chart would ably supplement Mr. Shinn's article on "Railway Accounts and Returns," and would present in an intelligible manner most of the facts which boards of directors, stockholders and the interested public, would care to know. Mr. Latimer promises to communicate to ENGINEERING NEWS a copy of his chart for publication, and also to let the Engineers' Club know soon of the new development in the divining rod.

At 4 P. M. we left Cleveland behind, passing out by the A. & Gt. W. Ry. through a valley filled with oil tanks, connected by piping with long side-tracks filled with trains of oil cars. Farther on we pass several blast furnaces and iron works in operation, and then through a beautiful and thrifty farming region, arriving at 8 P. M. at the little busy city of Youngstown with its iron works and manufactures. It was the second day of the County fair, and the Granger element, be it said, of more than usual intelligence and sagacity, lined the lobby of the Todd House and the sidewalks discussing the prospects of the "hoss trot" on the morrow. Others had gone to see a second-rate imported theatre troupe, and the roars of laughter and tears at times betokened the genuine sympathy of the audience. At its conclusion fifty men, old and young looked as if they wanted to elope with the heroine. Such is life, but not engineering. A bunk on the floor on the first floor under the roof, an early breakfast in the morning, and off we go to Pittsburgh, down the Mahoning Valley, until we strike the P., Ft. W. & C. Ry., thence to the Ohio River at Rochester, and along its banks until we arrive in the Allegheny depot. The Ohio is so low that you can scarcely recognize it. A cow could cross the stream at almost any point; navigation has practically ceased, and heavy coal flats await the first autumn rise which, this year, has been long deferred.

The sooner the government constructs its movable dam at Davis Bend and then follows that up by other dams lower down, the better will it be for the large interests of Pittsburgh and all western Pennsylvania. And we may say also, it will add much to the appearance of the stream at low-water. Judging from the high-water marks visible, the appearance at high-water is sufficiently ample.

MR. J. J. R. CROES, C. E., sends us some corrections in the questions regarding water works. We take this opportunity of thanking Mr. Croes, and also of calling attention to the fact that he was the Author of the series of questions while Chairman of the Committee on water works for the American Society, and did much valuable work in collating and digesting information on the subjects to which the questions refer.

WE print this week the Constitution of the American Society of Civil Engineers. This will be followed in our next issue by the By-Laws and such forms as may be of interest. We do this in order to attract attention to this organization, which includes in its membership much of the ablest engineering talent of the country, and has proved itself invaluable to the profession at large for its published papers and discussions, as well as for its potent influence on public sentiment and legislation. In order that the profession may have its proper influence on legislation in this country, and occupy a recognized social position, the individual units must be aggregated in definite bodies from which must be carefully excluded all empyrics, quacks, etc., so that membership shall be a *sine qua non* to public respect and confidence, as well as something more than laborer's wages for professional work. We hope in time to see every respectable engineer the member of some society, and at the same time the fact that a man does not belong to some society to be equivalent to a lack of recognition by his fellows, and to relegate him to subsidiary work. The American Society is, to some extent, the parent and model society in this country, and the purpose of the organization, and the latent influence which may exist in it for the good of the profession, should excite that careful consideration and attention from every engineer which the present abundant leisure gives ample opportunity.

A NOVEL bill was introduced in the House of Representatives on the 13th inst., by Gen. N. P. Banks, of Massachusetts. Its object is "to extend, facilitate and cheapen land and water transportation" and "to promote industry and labor without further appropriation of public property or increase of public debt." It provides that all moneys now due or to become due with

the accrued interest, on account of the Pacific railways and other corporations, is to be held as a separate and distinct fund to be used as Congress deems necessary in the construction and improvement of railways, canals, levees and other public works, such as will cheapen transportation in the several states and territories and in foreign countries.

This fund is to be invested in United States bonds, and when the bonds mature, again reinvested in the same manner. Whenever any appropriation is made the parties or corporation receiving the same are to give good and efficient security for its entire repayment, principal and interest. Whenever an appropriation is made that affects general interests, as well as that of individual states, Congress may provide that the advance from the fund shall be repaid by special assessments or taxes upon the trade or commerce interested and benefited, or upon the lands or other property that may have been improved, etc. Other provisions are added, but the newspaper reports are so vague that it is quite impossible to conceive their import at present.

PROBABLY the bill will be pigeon-holed in the Committee-room beyond resurrection. Of course, in the absence of detailed and explicit reports, it is quite possible to misjudge its import. But at first thought it strikes us as one of those circumlocution devices peculiar to the average "American Statesman," by which he imagines, under a multitude of forms and enactments, to build public works, etc., without the public feeling the burden. It is one of those cyclical acts that ends at precisely the same point whence it starts, and operates on the same principle as the man who lifted himself over the fence by his boot-straps. Beside, the bill is vicious in the careful provision which it makes for future "credit mobiliers." The sooner the American people learn that public works cost money, and that no circumlocution process or financial device can diminish the cost, serving only to veil public operations in a fog under cover of which the "Statesman" escapes, the better it will be for the public pocket and morals.

THE INTEREST VALUE AND FUTURE PROSPECTS OF AMERICAN RAILWAYS.

There is no question that now more thoroughly agitates that portion of the people who have money to invest, whether for estates, for insurance companies of every kind, or for individual uses, than the true interest value of the property of the railway companies of this country and their future prospects.

The changed position of the security and profitableness of railway investments within a few years, has caused immense losses of invested capital, not only to holders in Europe but more largely to our own people. This changed position has been not so much with railway companies of low credit as with those that have stood at the head in credit and profit. The panic of 1873 very rapidly developed the weakness of the lower class of roads, whose securities were mainly held abroad and of those more peculiarly speculative. But it was not until 1876 that the holders of the most highly appreciated railway investments were startled with the threatened injury, if not total loss, of their investments.

The shares and bonds of such companies are mainly held in this country. They have been selected as the depositories of the savings and the earnings of the poor, as well as for a profitable place for the surplus income of the well-to-do or the rich. The stoppage of dividends and the non-payment or the deferred payment of interest by such companies, has caused wide-spread distress and general disgust.

Investors as a rule connot affix a true value to the stocks or securities, nor investigate the management of railway companies, and can neither comprehend their reports nor the influences that affect their profits. Yet there are certain general points which may help some to come to a better understanding of the direction to which such securities tend, and afford somewhat of a guide by which they may read their future.

These are:—

First. The rules by which the cost price of a railway should be determined.

The railway interest in this country has expanded from 31,286 miles in 1861, to 77,470 miles in 1877.

Without estimating the amount of capital that has been sunk during these fifteen or sixteen years, the result shows a gain of 46,184 miles of railway.

These 46,184 miles of railway were built during the time of high prices for labor and material,—the civil war giving full employment to the people and the Government being a good paymaster. There was seemingly great prosperity. The depreciated currency in use made nominal prices for the productions of labor and capital. The railways built and equipped under such conditions necessarily represent in their cost, these high prices. Since their opening traffc on these lines has been developed; profitable connections made with other lines, more money has been made, in some few instances, than has been paid out as interest and dividends; and there has been time to affect valuable organizations in the management of the roads. All these items of gain are a set-off to the extra cost of construction and equipment.

A proper cost price of a railway can only be determined by average prices of labor, material, and equipment under a settled currency, which is equal to the world's standard of value, gold or silver.

The way then to judge of the proper cost at which any railway should stand to its proprietors is to bring it down to this test, the items of gain above alluded to being properly estimated. The difference between the cost, as represented on the books of a company and the proper cost, thus estimated, must be excepted as so much *loss*. The distribution of this *loss* between the shares and securities plainly commences with the shares, and works backward towards the earliest security.

Second. The value of a railway is another question and must be differently determined; this depends on its money-earning power. It will be excepted without discussion that the price received for the transportation of freight and passengers on a railway must be based on its proper cost. That is, neither extravagance in building, nor being built at nominally high prices by reason of a depreciated currency, are a warrant for charging higher rates for conveyance of freight or passengers than would be proper, under economical construction, and when built at specie prices, unless where the freight paid for is in money equivalent to gold or silver. This principle provides for the times we have passed through, when transportation was paid for in depreciated currency and at relatively higher prices. The value of any railway company is, then, to be judged by its surplus after paying expenses.

Third. The distribution of the surplus.

This distribution commences with the oldest secured debt and proceeds downwards to the shares, and it depends on the amount of this surplus whether any of the capital, represented in the difference between a proper and fictitious cost of construction, shall participate.

At this point there comes in a question, which gives some ground for a charge of unfairness, and in the reconstruction of some companies it has been recognized. In the distribution of this surplus the interest on the oldest security is paid at face value, and so on as far as the surplus goes. This amount of interest is paid without reference to the amount or the specie value of the money that was received for it. The operation of this bears very heavily upon the lower security and shareholders, and in many instances prevents the payment of interest and dividends to holders, when, if the earlier bonds had been paid in specie, or interest paid according to the real value of the money paid for them, the holders of later bonds and of shares would receive fair interest on their money; and it has caused entire losses of investments, and the reconstruction of roads that otherwise might have been carried on to the profit of all parties. On the examination, then, of any railway company's accounts, it is very important to note the date and price at which their bonds were sold, and the specie equivalent of the money received; for the less of specie value that was received, the less are the following bonds and shares worth.

Fourth. The financial complications with other railway or other companies.

The great extent of our country,—of our coasts, of our rivers,—naturally breeds large ideas among the people. We like large operations. Power and position go with them. It is said to be only a question of systematized working that marks the difference between the management of a large or small corporation. This tendency has led many of the larger railway companies to extend their influence and power, by gaining, through leasing and guaranteeing securities, the control of other railways, until, in some cases, the lines of railway thus secured far exceed, in cost and importance, the lines of the company that controls them.

Other companies, not content with the ownership and management of their own and other leased lines, have been led into the purchase and mining of coal, iron ore, the ownerships of vessels, have become interested in various manufactories, etc. They have been led into such leases, guarantees, mining, and other operations, by the desire to enhance the value of their own property, and, while the country was prosperous and money being rapidly made, the policy seemed to be successful. Two things they omitted to estimate properly: First. That a railway company cannot manage any kind of work as cheaply as an individual can. Second. That it is not true that it is but a mere question of system whereby a large operation can be managed as well as a smaller one. In all management there must be a head, and work may readily accumulate that will be too much for the mental and physical strength of any man, though aided by the best system. It was also well to remember that with the increase of duties the number of men who have fitting capacity for such work diminishes, and it is a safe rule to allow no corporation to extend its business to a point beyond which there will be any material difficulty in finding persons fitted to occupy its highest places.

The financial aspect is important. The fact of a lease being made or a guarantee accepted, indicates that the rent paid is a full one, and the necessity of a guarantee is very great to give value to the article guaranteed. Therefore, the profit that is to be gained from a lease or a guarantee is to be measured by the profit that accrues to the principal in the control of a certain traffic on its own line. The experience of this country is largely against such attempts to control traffic or to make profits.

In estimating, then, the value of the shares of a company, this element of leased lines and guaranteed securities comes in to increase the difficulties of arriving at a safe result; it so largely increases the chances of failure to provide sufficient profit to pay a dividend.

Fifth. The influence of competition on profits. The investigator may have satisfied himself as to cost of construction, as to fairness of prices on which leases were based, and value of guarantees in the value of property the guaranteed bond may cover. But after all this, the ability to meet interest and dividends, leases and guarantees, depends on the profits made by the principal company on the leased and guaranteed lines, by the coal or iron companies, etc. The best judgement may have been practiced, but of what avail is it, or are all these things, when an imprudent competitor may have the power to destroy all chances for profit.

After all the failures and bankruptcies of railways, on what do they ultimately come as to their dependence? Their local traffic and travel. This is all that can be secured or considered its own, by any railway company, and the wise and prudent investor will come at last to select the shares and securities of such companies as encourage and have a good local traffic, and have no outside commitments or engagements. He will base his estimate of profit on this local business, and be willing to pay for securities or shares as he estimates its value. But while the investor in railways is brought to this seeming last point, yet, under the Free Railroad Laws, now so prevalent in the states, there is not much safety here. The upshot of the whole matter is that there is but little security in railway investments in this country, and that some action is needed by the General Government that will, if possible, give to the system the element of security for investment which it does not now possess.—*The Railway World.*

AMERICAN SOCIETY OF CIVIL ENGINEERS.

CONSTITUTION.

ARTICLE I.—This association shall be called the "AMERICAN SOCIETY OF CIVIL ENGINEERS."

ARTICLE II.—Its object shall be: The professional improvement of its members, the encouragement of social intercourse among men of practical science, the advancement of engineering in its several branches, and the establishment of a central point of reference and union for its members.

ARTICLE III.—Among the means to be employed for

attaining these ends, shall be periodical meetings for the reading of professional papers and the discussion of scientific subjects; the foundation of a library, the collection of maps, drawings and models, and the publication of such parts of the proceedings as may be deemed expedient.

ARTICLE IV.—Civil, Military, Geological, Mining and Mechanical Engineers, Architects, and other persons who by profession, are interested in the advancement of science, shall be eligible for admission in their appropriate class.

ARTICLE V.—The officers of the Society shall consist of a President, two Vice-Presidents, a Secretary, Treasurer, Librarian, and five Directors, who shall be elected by written ballot, by a majority of votes, at the Annual Meeting of the Society, and shall hold their offices until others are elected. Any vacancy occasioned by resignation or otherwise, may be filled at the next monthly meeting after notice of said vacancy.

ARTICLE VI. —The President, Vice-President, Secretary, Treasurer and Directors shall constitute a Board of Direction, and shall be the trustees of this Society, under the Act of the Legislature of April 12th, 1848, chapter 319, Laws of the State of New York.

ARTICLE VII.—The Board of Direction shall meet within one week after their election, and the first business in order shall be the appointment of a Standing Committee of three on Finance, and of a standing committee of three on Library.

ARTICLE VIII.—The President, and in his absence the Vice-Presidents in rotation, shall preside at all the meetings of the Society; and in case of their absence, a President pro tempore shall be appointed.

ARTICLE IX.—The Secretary shall keep an accurate record of all the transactions of the Society and of the Board of Direction, and shall issue all notices.

ARTICLE X.—The Treasurer shall have charge of the funds of the Society, receive all assessments, and pay all bills and orders approved by the President, or the Chairman of the Finance or Library Committees. The duties of the Secretary and Treasurer may be united in the same person, if the Society think proper.

ARTICLE XI.—It shall be the duty of the Librarian to take charge of the library of the Society, and to see that all books are marked with the name of the Society, numbered, and recorded in a catalogue. In respect to the management of the Library, he shall conform to such regulations as may be prescribed by the Society or by the Board of Direction.

ARTICLE XII.—The duties of the Board of Direction shall be: to have a general care of the affairs of the Society; to apply the funds in the treasury; to recommend the amount of assessments and appropriations for specific purposes, and to make a report on the affairs of the Society, embracing the report of the Treasurer, at the Annual Meeting.

ARTICLE XIII.—The Finance Committee shall have supervision of the accounts of the Society, shall examine all bills and demands, audit the accounts of the Treasurer, and certify to his annual report.

ARTICLE XIV.—The Library Committee shall have supervision of the rooms, printing and library of the Society, and shall apply to the purchase of books or other articles of permanent value to the Society, such sums as may be appropriated.

ARTICLE XV.—At any regular meeting of the Society, seven Members shall constitute a quorum for the transaction of business. But the action of a less number at any monthly meeting, at which a quorum is not present, may be entered on the journal, provided such actions does not affect the rights of the association, or any member thereof.

ARTICLE XVI.—The active members of the Society shall be divided into three classes, to be styled respectively, Members, Associates, and Juniors, and each person, when duly elected and qualified, shall receive a certificate of membership, indicative of the peculiar class which he represents. Associates and Juniors shall possess all the rights and privileges of Members, excepting the right of voting.

ARTICLE XVII.—To be eligible as a Member, the candidate must have been in the actual practice of his profession for at least seven years, and have been in charge of work or of operations in his particular branch of engineering or of science. A diploma from any collegiate institution in good standing, conferring the degree of C. E., shall be considered equivalent to two years' service.

ARTICLE XVIII.—To be eligible as an Associate, the candidate must be one whose connection with science or the arts qualifies him to concur with Civil Engineers in the advancement of professional knowledge. To be eligible as a Junior, the candidate must have been in the actual practice of his profession for at least two years.

ARTICLE XIX.—All candidates for admission to the Society must file statements by themselves, setting forth the grounds of their claim to be elected; be proposed by at least two members of the Society, to whom they must be personally known, and a notification of the same sent to each Member whose place of address is on record. Each proposition with the name of the proposers, must be posted in some conspicuous place in the rooms of the Society, for at least thirty days before being submitted to vote. All such papers and applications shall be laid before the Board of Direction, and be reported upon, previous to action by the Society.

ARTICLE XX.—In elections for membership of either class, Members shall vote by letter, or by ballot in the usual way, and the result shall be announced at the next regular meeting held after thirty days have elapsed from the time of mailing the notification. Three or more ballots cast in the negative shall exclude. Members notified but not responding, shall be classed as having voted in the affirmative.

ARTICLE XXI.—On being thus elected, the candidate must subscribe to the Constitution and By-Laws (in the terms set forth in form A, in the Appendix), and pay to the Treasurer of the Society such sum as may be determined on, under the authority of Article XXII of the Constitution, as the regular entrance fee and yearly assessment, before he can be entitled to receive his certificate of membership. If this be not done within six months from notification of election, said election will be considered void.

Article XXII.—Persons thus elected and duly qualified, who reside in the city of New York, or within fifty miles thereof, shall be deemed Resident; and those who reside beyond those limits shall be deemed Non-resident.

Article XXIII.—The amount of entrance fee to be paid, as well as the annual dues or assessment for the support of the Society, shall be determined from time to time, at some regular meeting of the Society, provided that notice of intended action thereon shall have been given at a previous regular meeting. No alteration in the amount of said fees or assessments shall apply to the fiscal year during which it is made, but shall take effect on and after the first Wednesday in November, next succeeding the day of the date of said alteration.

Article XXIV.—Persons residing out of the United States may be elected Corresponding Members, in the same manner as hereinbefore provided for the choice of immediate members.

Article XXV.—Honorary Members, not exceeding forty in number, having been nominated as required in Article XIX, may be elected by a unanimous vote. Corresponding and Honorary Members shall be subject to no fees or assessments. They may attend any meetings of the Society, but shall not be entitled to vote.

Article XXVI.—There shall be a fund called the "Fellowship Fund," devoted exclusively to the publication of the papers read before the Society. Any persons, whether members or otherwise, if acceptable to the Society, may subscribe thereto. The subscribers to this fund shall be called "Fellows of the Society." Persons who are not Members and who become Fellows shall be entitled to all the privileges of the Society, excepting the right to vote. Members who become Fellows shall, in addition to all the rights they possess as Members, be entitled to receive duplicate copies of all the publications of the Society.

Article XXVII.—In case of the non-election of any person ballotted for, no notice shall be taken thereof in the minutes.

Article XXVIII.—Whenever any person is elected, the Secretary shall immediately inform him of the same by letter (from B in the Appendix), and the election of Corresponding and Honorary Members shall be likewise communicated to them by a letter suited to each particular case; but no person shall be considered as a Corresponding or Honorary Member, unless he signify within six months his acceptance of membership.

Article XXIX.—Resident Members, Associates or Juniors, who may remove beyond the limits prescribed in Article XXII, for the term of one year or more, shall be subject to the payment of such fees and assessments only as are prescribed for Non-residents, provided that the person thus removing shall give the Secretary of this Society written notice of such removal. The privilege, however, shall not apply to any fractional part of the fiscal year.

Article XXX.—Every person admitted to the Society shall be considered as belonging thereto and liable to the payment of all assessments, until he shall have signified to the Secretary his desire to withdraw; when, if his dues have been fully paid up, his name shall be erased from the list of members.

Article XXXI.—Any person admitted to the Society, who shall refuse to pay any assessment or other dues to the Society, or who shall neglect the same for the term of six months, after due notice is issued (in the Form C, in the Appendix), shall cease to be a member.

Article XXXII.—The permanent place for the transactions of the business of this Society shall be in the city of New York.

Article XXXIII.—The Annual Meeting for the election of officers and the hearing of the annual reports, shall be held on the first Wednesday in November.

Article XXXIV.—The Annual contributions shall become due at the time of the Annual Meeting, and shall be payable in advance; and it shall be the duty of the Secretary to notify the amount of assessment or subscription due, at the time of giving notice of such meeting.

Article XXXV.—Proposed amendments to this Constitution shall be first submitted to the Society, and seconded, and then sent by letter to the several Members of the Society, at least twenty-eight days previous to the Annual Meeting. Such amendments shall be in order for discussion at such Annual Meeting, and shall be voted upon by letter ballot, within sixty days after the date of said meeting. The vote shall be counted by the President and Secretary, and if two-thirds of the votes are in favor of said amendment, it shall be declared adopted, and the result announced at the next regular meeting of the Society thereafter.

The forthcoming report of General Humphreys, Chief of Engineers, will contain the following statements relative to the improvement of the Illinois river: The project for continuing the work of improving the river by dredging and building dams, jetties, and retaining-walls was successfully carried on, but not entirely completed, owing to suspension of work caused by long continuance of floods in the river, and the fact that, of the appropriation made on the 14th of August 1876, only $10,000 was alloted for use in the remainder of the working season of 1876. This amount was chiefly applied to the restoration of channels obstructed by detritus from summer floods, which have demonstrated the necessity of having a reserve fund and proper equipment always in readiness for such work, and the estimate for completing the improvement of Illinois river embraces the requisite amount for this purpose, which will account for its increase over the original estimate.

July 1, 1876, amount available.....	$39,691	
Amount appropriated by act approved Aug. 14, 1876.....	40,000	
		$ 79,691
July 1, 1877, amount expended during fiscal year.....	49,317	
July 1, 1877, outstanding liabilities...	2,750	
		52,067
July 1, 1877, amount available.....		$ 27,624
Amount estimated required for completion of existing project.....		145,000
Amount that can be profitably expended in fiscal year ending June 30, 1879.....		154,000

The decree and foreclosure and sale in the suit of the Farmers' Loan and Trust Company against the Erie Railway Company and others, entered recently, is on a mortgage made to the plaintiffs for $25,000,000, on which over $3,000,000 interest was due. The order is made subject to the liens of six prior mortgages, and provides for a sale to the bondholders if they form a company, or a transfer of the bed to them, the sale to be made in New York, for cash, but not until the auxiliary suits in New Jersey and Pennsylvania are concluded.

TRAMWAY STATISTICS.

Name of Company.	Miles of Line open.	Capital received.				Capital expended.			Number of Horses.	Number of cars and omnibuses.	Traffic			Working Expenses.				Percentage of Working Expenses to Gross Receipts.	Dividends, Ordinary shares.	
		Ordinary shares.	Preference shares.	Debentures and Loans.	Total.	Construction, Equipment and Buildings.	Horses.	Total.			Passengers carried.	Miles run.	Traffic Receipts.	Receipts per mile of tram.	Receipts per mile run.	Working and general Expenses including Track Repairs.	Per Mile of Tram.	Per Mile run.	Track Repairs.	Per Mile of Tram.		Per cent.	Total.
		£	£	£	£	£	£	£					£	£	£	£	£	d.	£	£			
North Metropolitan.							Horsed by L.G.O.C.																
Half year ending June 30, 1875	29½	600,000	...	69,700	669,700	662,662		682,662	..	164	13,488,354	1,714,017	112,372	3,809	15·73	84,748	2,872	11·85	2,362	80	73½	8	24,000
" Dec. 31, 1875	30½	600,000	...	86,200	686,200	684,566		684,566	..	168	14,267,563	1,841,767	121,894	3,996	15·89	91,194	2,990	11·91	2,387	78	73½	8½	25,500
" June 30, 1876	30½	600,000	...	85,000	685,000	684,632		684,632	..	166	13,065,184	1,768,559	113,231	3,712	15·37	88,604	2,905	12·02	2,467	81	76⅓	8	24,000
" Dec. 31, 1876	30½	600,000	...	85,000	685,000	684,632		684,632	..	166	13,789,270	1,800,441	119,468	3,917	15·92	89,269	2,927	11·89	4,271	140	73	9	27,000
London Tramways.																							
Half year ending June 30, 1875	20¼	250,000	80,000	94,700	424,700	362,116	50,208	412,324	1,209	139	7,583,400	1,224,272	67,661	3,399	13·50	60,702	2,975	11·81	1,063	52	..	nil	..
" Dec. 31, 1875	20¼	250,000	80,000	99,750	429,750	368,057	49,708	418,665	1,117	145	8,207,567	1,273,371	70,389	3,543	13·51	63,109	3,116	11·89	1,549	75	87¾	..	..
" June 30, 1876	20¼	250,000	80,000	101,050	431,050	372,575	44,093	416,668	1,060	147	7,881,537	1,192,542	67,454	3,331	13·57	66,192	3,268	13·32	2,919	144	96⅓	..	..
" Dec. 31, 1876	20¼	250,000	80,000	101,050	431,050	375,033	44,093	419,126	1,060	147	7,713,999	1,137,161	68,033	3,359	14·35	51,597	2,548	10·88	1,694	84	75¾	3	3,750
London Street Tramways.																							
Half year ending June 30, 1875	4½	90,490	.....	37,300	127,790	132,925	16,308	149,233	400	48	2,575,320	330,174	20,714	4,602	15·05	16,171	3,593	11·75	550	122	..	7½	2,892
" Dec. 31, 1875	5½	94,900	.....	42,000	136,900	13 4,826	16,308	151,134	400	48	2,778,701	367,167	23,233	4,224	15·10	18,689	3,398	12·21	518	94	..	7	3,321
Year " Dec. 31, 1876	5½	100,000	.....	40,750	140,750	137,028	16,538	153,566	400	48	5,620,880	772,598	46,829	8,514	14·55	37,081	6,742	11·51	1,246	226	80¼	6	5,936
Glasgow Tramways.																							
Half year ending June 30, 1875	15	287,644	.....	.....	287,644	235,599	25,950	261,549	865	139	.....	845,306	54,744	3,649	15·54	44,469	2,964	12·62	..	..	..	nil	..
" Dec. 31, 1875	15	287,644	.....	.....	287,644	239,324	32,375	271,699	925	149	.....	913,536	63,010	4,200	16·55	49,422	3,294	12·98	..	..	76½	3	4,375
" June 30, 1876	15	287,654	.....	.....	287,654	272,410	43,503	315,973	1,180	182	.....	1,074,528	67,579	4,505	15·09	52,104	3,477	11·65	..	..	75	3	4,375
" Dec. 31, 1876	15	287,654	.....	.....	287,654	288,931	51,177	340,158	1,368	197	.....	1,235,832	75,000	5,000	14·56	56,530	3,768	10·97	..	..	74	4	5,833
Edinburgh Tramways.						Special circumstances.							Including omnibus receipts.										
Half year ending June 30, 1875	13	149,060	.....	40,450	189,510	195,053	12 979	208,032	407	43	.....	352,735	26,030	2,002	17·71	10,522	1,501	13·28	664	51	..	6	4,500
" Dec. 31, 1875	13	149,540	.....	45,500	195,040	198,317	16,017	214,334	478	41	.....	415,031	29,603	2,277	17·11	22,499	1,730	13·01	1,031	79	..	6	4,500
" June 30, 1876	13	149,550	.....	40 262	189,812	200,761	17,834	218,595	482	48	.....	.....	28,904	2,223	..	24,601	1,893	..	703	54	82½	4	3,000
" Dec. 31, 1876	13	149,720	.....	40,130	189,850	203,853	16,009	220,762	457	48	.....	...	34,622	2,433	..	22,498	1,730	..	1,689	130	70	8	6,000
Dublin Tramways.						Special circumstances.																	
Half year ending June 30, 1875	15	239,956	.....	15,000	254,956	235,827	17,258	253,085	486	79	2,734,807	495,137	33,152	2,210	16·06	24,741	1,649	11·99	1,137	76	73½	6	7,200
" Dec. 31, 1875	15	240,000	.....	15,000	255,000	235,827	16,088	251,915	456	85	3,049,925	543,587	36,738	2,449	16·22	25,079	1 672	11·07	1,404	93	67	8	9,600
" June 30 1876	15	240,000	.....	15 000	255,000	235,827	17,971	253,798	500	79	2,904,592	.....	35,120	2,341	..	23,919	1,593	..	1,740	116	67	8	9,600
" Dec. 31, 1876	15	240,000	.....	15 000	255,000	235,827	17,364	253,191	486	81	3,169,045	.....	38,129	2,542	..	25,492	1,699	..	2,243	149	66	9	10,800
Cardiff Tramways.																							
Half year ending June 30, 1875	2½	35,000	.....	.....	35,000	32,747	1,680	34,427	56	12	490,627	59,992	4,038	1,615	16·35	3,320	1,328	13·28	67	26·8	about 68	10	750
" Dec. 31, 1875	2½	35,000	.....	.....	35,000	32,847	1,680	34,527	55	12	632,159	66,874	5,667	2,106	18·90	3,366	1,344	12·05	113	45·2			1,750
Portsmouth Tramways.																							
Half year ending June 30, 1875	3	42,514	.....	.....	42,514	40,624	1,890	42,514	63	12	489,282	76,045	3,440	1,146	10·86	3,077	1,025	9·57	57	19	about 83	3	350
" Dec. 31, 1875	3	42,695	.....	.....	42,695	40,735	1,890	42,625	63	12	432,448	82,160	3,994	1,331	11·54	3,122	1,040	9·11	17	5·6			650
Plymouth Tramways.																							
Half year ending June 30, 1875	1¾	33,883	.....	.....	33,883	31,483	2,400	33,883	76	12	836,863	63,002	4,748	2,713	17·13	4,330	2,474	16·49	57	32·57			400
" Dec. 31, 1875	1¾	35,921	.....	.....	35,921	33,521	2,400	35,921	82	12	734,489	68,427	5,469	3,125	19·18	4,567	2,617	16·01	53	30·30	about 85	4½	800

STREET TRAMWAYS.*

BY ROBINSON SOUTTAR.

Continued from page 314.

Mr. HUNTINGTON said the question of tramways had taken such a footing in English construction that it was quite time to have a fair and deliberate discussion concerning it. Tramways would in future form an important part in conveyance, especially in situations where the cost or the site of a railway might be inexpedient, and that not only in England but also in the Colonies and in other places where English skill might be called for. He regretted that the Author had given so little information as to the cost of the different systems in relation to the actual construction. The statement that the cost varied from £1,500 to £6,000 a mile was very vague. He had been interested, as a shareholder, in undertakings of that kind, and had found the information given at public meetings to be of an unsatisfactory character. In London certain tramways might be said to be in full working condition, such as the North Metropolitan and the London or South system; in Dublin also they had been at work for a long period. Some were worked by horse contract, like the North Metropolitan and others horsed themselves, like the London and the Dublin. The capitals of the companies varied considerably, as also did the results of working the roads. In making a comparison, in addition to the tramways, he had thought that it would be instructive to join thereto the railway system and the omnibus system, for which purpose he had selected the Metropolitan, the Metropolitan District, and the North London railways, as a group approaching the nearest to the tramways for conveying passengers. The length of the North Metropolitan tramway was 30½ miles; the London, 20¼ miles; the Dublin, 15 miles; the length of the group of railways was 32 miles; and the General Omnibus Company covered a range of 58½ miles. The cost for six months to the 31st of December, 1876, of the North Metropolitan had been £22,447 per mile; of the London, £20,697; of the Dublin, £17,125; of the group of railways, £578,320; and the capital of the General Omnibus Company was equal to £10,264 per mile. To put the North Metropolitan on a fair level with the others, the cost of horse stock and equipments (on the London scale) should be added, or £3,040 per mile, making that system cost £25,487 per mile, or about £6,000 per mile dearer than in London. The item "Tramways," which included the roads, paving, engineering, extra works, preliminary and parliamentary expenses, cost on the London £15,005 per mile, which might be analyzed thus:—

	£
Double line of tramways	3,000
Paving, 6 yards wide	8,000
Engineering	1,000
Extra works, &c.	2,000
Parliamentary, &c.	1,000
	15,000

Besides these expenses the London cost £2,177 per mile for horse stock, also £1,959 per mile for cars and other plant, and £1,555 per mile for land and buildings; while the cost of the North Metropolitan for the last two items only was £1,077 and £1,345 per mile respectively. Taking the single passenger as the unit, the North Metropolitan carried 2,457 per mile per day; the London, 2,070; the Dublin, 1,150; the railway group, 7,735; and the General Omnibus Company, 2,450. The receipts per passenger were: North Metropolitan, 2.08*d.*; the London, 2.10*d.*; the Dublin, 2.88*d.*; the railways, 2.57*d.*; the General Omnibus Company, 2.53*d.* The horsing of the North Metropolitan was done by the General Omnibus Company, and the contract amounted to 0.88*d.* per passenger; the London horsed itself, and the cost, including renewal of horses, was 0.81*d.* per passenger, and the Dublin cost for horsing and renewal, 0.88*d.* The locomotive cost on the railways was only 0.35*d.* per passenger. The cost per passenger for the horsing of the General Omnibus Company was 1.31*d.* With regard to the railways, the returns contained the gross receipts for goods and the total gross receipts, so that the gross passenger receipts could be ascertained; but, as far as expenditure was concerned, the returns combined both, and a separation therefore had to be made by computation and approximation. The total cost under each system respectively

*From Proceedings of the Institution of Civil Engineers, London.

was: North Metropolitan, 1.51*d.*; the London, 1.57*d.*; the Dublin, 1.88*d.*; the railways, 0.88*d.*; and the General Omnibus Company, 2.11*d.* per passenger. The general results showed that the railway system had at all events the advantage of economy. The probable cost of steam on tramways had been stated by the Author as 25*s.* 1*d.* per car per day, which nearly agreed with his own calculation. He had not taken into account, what the Author had included, the renewal of engine, &c.; in the Tramway reports he found it as renewal of horses, plant, and other matters and left it to stand as the equivalent of the new form of renewal.

	s.	*d.*
Fuel, 7 cwt. (during eighteen hours)	7	11
Engineman and stoker at 6*s.* per day above the present wages of driver	6	0
Sundries, oil, waste, tools, materials, assistance, &c	1	10
Interest on capital for reforming road and stock	2	10
Contingencies	1	5
Renewals, now charged for horses ½*d.* per passenger	5	2
Total per car per day	25	2

Therefore, withdrawing the renewals from this estimate as being elsewhere included, and taking the steam alone, he calculated the amount to be as nearly as possible £1 per car per day. Thus the cost on the North Metropolitan, running one hundred and forty cars per day, would be £140; and applying that to 14,000,000 passengers in the half-year, the amount was 0.44*d.* per passenger; also in the case of the London it was 0.45*d.* That gave a *bona fide* gain of about 0.4*d.* in favor of mechanical motive power, which was equal to an increased dividend of 8 per cent. or more. By comparing the tramways with the railways in the subjoined table it would be seen that, although the system by steam had great advantages in large cities, where passengers were numerous and distances short, the cost of steam was considerably augmented in country districts, where there were fewer passengers and longer distances to travel. During the six or seven years that tramways had been working, roads, cars, plant, and horses had been more or less subject to renewals. The roads cost about £4,000 per mile, double line, including engineering and other matters exclusive of the paving. Up to the present time the total renewal from the 1st of January, 1871, of the tramway upon the North Metropolitan had amounted to £601 (or £777 including the contractor's outlay) out of £ 4,000, and on the London to £936. If renewals went on at that rate obviously a considerable period would elapse before the tramway was thoroughly worn out; but there was a slow annual increase in this item, which in 1871 was about £88, and in 1876 became £220 per mile on both tramways. With regard, however, to the cars and other plant, the original outlay was £1,133 per mile on the North Metropolitan, and the company has already spent in renewal £1,311. On the London the original cost was £1,919 per mile, and up to the present the repairs had amounted to £1,442, so that the American statement of a ten years' life did not appear to be borne out. For horses the original cost per mile on the London amounted to £8,480, and the renewal to £1,540. The actual reserves in hand to meet the renewals exclusive of these annual outlays were for the North Metropolitan £738, and for the London £595 per mile; sums insufficient, seeing that the annual outlays were already £250 per mile for roads, cars, &c., and £142 per mile for horses. With regard to the tramway itself, he had received the following particulars three or four years ago from a gentleman connected with the construction of the line. The price of iron, timber, and labor was constantly varying at the time, so that the figures could not be taken as an accurate estimate of what the real cost had been:—

	Per yard. *s.*	*d.*
Rails, ties, spikes, bolts, dogs, fishes, &c. rails 50 lbs. per yard at £10 10*s.* delivered)	10	6
Timber creosoted and shaped	2	0
Fixing and laying, including crossings	1	0
Maintenance for one year	0	6
Contingencies, cartage, lights, watching, waste and cutting	1	6
Risk and profits 10 per cent	1	6
Total	17	0

1,760 yards at 17*s.* = £1,496, say £1,500 per mile of single line.

Paving with 7-inch cubes of granite for a double road with concrete bottom cost:—

	Per sq. yd *s.*	*d.*
Granite paving set to tramways, 18 feet wide, materials and labor	11	0
Concrete, averaging 6 inches thick, including excavation and removal of road	1	6
Contingencies, grouting, carting, watching, removing materials, and sanding	1	0
Maintenance for one year	0	3
Risk and profit to per cent	1	3
Total	15	0

1,760 × 6 × 15*s.* = £7,920, say £8,000 per mile of double line.

He has also obtained the following particulars:—Gauge, 4 feet 8½ inches with a 4-feet midway. Rails, dogged on kyanised longitudinal bearers 21 feet long, with four transverse bearers bolted with ¾ inch bolts and nuts to the gauge, the weight being, as computed after measurement, 45 lbs. per yard. The gauge was kept by the paving. The dogs were 4 inches long, ⅝ inch in diameter, and were driven into drilled holes on both sides of the rails, slightly angular, about 3 feet apart, one side dividing the space with the other. The dogs were driven into the timber after being well screwed down by a double-sided square-threaded cramp. The joints were fished with plates 9 inches long, ⅜ inch thick, let into the longitudinals. The timbers were bedded in Portland cement concrete 6 inches thick, and the paving was laid upon the same. The sifted rubble of the road was used for grouting, and fine red sand was laid above all. The paving extended 1 foot 6 inches on each side of the outer rails, 7-inch granite cubes being used. Extra works, crossings, and sidings, were not included in the above estimates. The following table illustrated the foregoing remarks more correctly:—

Details of the comparative Cost of conveying One Passenger by Tramway, Omnibus, and Railway; the two former systems for One Year ending the 31st of December, 1876, and the Railway system for One Year ending the 31st of December, 1875:

Item.	Tramways. North Metropolitan.	Tramways. London (South).	Tramways. Dublin.	Omnibus. London General.	Railways.* North London, Metropolitan and District.	Railways.* Nine great trunk lines from London.
	d.	*d.*	*d.*	*d.*	*d.*	*d.*
Horsing [net]	0.897	0.808	0.761	1.139	...	...
Renewal of horses	...	0.156	0.099	0.215	...	...
Locomotive, passengers only	...	...	...	...		
Wages	0.358	0.349	0.482	0.490	0.348	1.745
Miscellaneous	0.066	0.091	0.083	0.019		
Repairs of cars	0.067	0.090	0.101	0.136	0.076	0.476
" road	0.060	0.072	0.157	...	0.123	1.286
" plant	...	0.016	0.027	0.062		
Rents, rates [net]	0.047	0.127	0.095	0.058	0.076	0.275
Duties	0.006	0.009	...	0.006	0.094	0.500
Compensations	0.007	0.025	0.026	0.012	0.015	0.228
Law and Parliamentary	0.023	0.026	0.034	0.031	0.151	0.804
General [net]	0.010	0.013	0.041			
Total cost	1.541	1.782	1.906	2.168	0.883	5.314
" receipts	2.078	2.076	2.895	2.552	2.576	13.031
Gross profit	0.537	0.294	0.989	0.384	1.693	7.717
Capital expended per passenger, adding horses	6.856	6.420	10.382	2.800	31.160	99.520
Passengers per mile per day	2,405	2,104	1,106	2,400	7,735	117
	£	£	£	£	£	£
Cost per mile	25,487	20,697	17,125	10,264	578,320	58,245
Miles open, all as in double line	30¼	20¼	15	58¼	32	5,875

*The cost of goods is eliminated from the railways.

Mr. Head had not studied the subject very much, but he had had a great deal to do with traction engines on roads. In considering the application of steam to tramways, it should be remembered that the gradients could not be altered, so that the engine had to work upon a variety of gradients according to circumstances. Two kinds of engines—separate and combined—had to be constructed for tramway cars. There were many advantages in the separate engines constructed by Mr. Merryweather and Mr. Hughes. The companies using those engines could employ their present rolling stock; the passengers had not the same fear of being blown up if the boiler should burst as when the engine and car were combined; and the public had an idea that the system was the right one from association with railway trains. At the same time, looking at the gradients of the lines in London, Edinburgh, Liverpool, and other places, he thought there would be a good deal of difficulty in getting an engine weighing from 4 to 5 tons up some of the inclines in wet foggy weather. It was difficult, however, to bring data forward of what could be done under such circumstances. The experience with traction engines on roads showed that in damp weather adhesion was small. Horses could always haul the cars, for, if two would not suffice, a third, and even a fourth could be added; but if an engine could not get on in wet weather the whole traffic might be blocked. With an engine on the principle of Mr. Grantham's there was the whole of the adhesion from the combined weights of the engine and boiler, the car and the passengers. It was unnecessary to say that adhesion was practically the keystone to the propelling power of the car, and that an engine of great weight had more power to propel itself than one of light weight. These important matters must be cleared up before tramway companies could decide upon the best engine to be employed. There might be one or two level lines on which a separate engine could be used with advantage, but he thought there were many lines in London which could only be worked safely with a combined engine and car.

Mr. Longridge said it was evident that separate engines could only be employed where there were easy gradients. He had seen an engine of Mr. Merryweather's at Vienna, and it struck him at the time that there would be considerable difficulty with a steep gradient. It weighed 3½ or 4 tons, and, including car and passengers, the total weight would be about 10 tons. With a gradient of 1 in 20 that weight would require a tractive force of about 1,482 lbs. He took the friction of the engine at 20 lbs., and of the car at 15 lbs. The insistent wetght was the weight of the engine itself, 4 tons, and he believed that in ordinarily slippery weather the adhesion would be not more than one-tenth, or 896 lbs. Under those circumstances he did not think it possible to work with any satisfaction. Much the same thing applied to Mr. Grantham's car, which he also saw at Vienna. It went very well on level ground, or on a moderate inclination, and there was no nuisance from blast, sparks, or smoke; but in that case the engine was placed at one end of the car, and the driving wheels beside the engine. About two-thirds of the way towards the other end there was a bogie with four wheels, and the only adhesion that could be obtained was the adhesion upon the driving wheels of the engine, which would not amount to more than one-half of the total weight. The same difficulty therefore arose as in the case of Mr. Merryweather's car, and he knew that considerable trouble had been exper-

ienced at Vienna with a gradient of 1 in 24 when the rails were at all out of order. It was not only a slipperiness of the rails that affected the tramway, but their inequalities. The constant passage of heavy traffic made it impossible to keep the rails in the same order as on a railway, so that one wheel would perhaps bear scarcely at all on one rail and the other wonld bear very heavily. For steam traction it would be necessary to devise some means of utilizing the whole of the carrying wheels of the car, and that he thought might be readily accomplished with Mr. Grantham's car. Another difficulty in the way was the great variation in the work to be done at different times. In the case of Mr. Merryweather's car, running nearly empty on a level, at 8 miles an hour, a tractive force was required of 2½ HP., whereas on a gradient of 1 in 20, a tractive force of 19 HP. was needed. With the small boiler necessarily used in such cases, he considered it would be difficult to regulate the fire and the generation of steam so as to meet those varying conditions. The steam would sometimes blow off with violence, which would be objectionable, and would perhaps be experienced with almost all steam engines. No doubt many objections would be avoided by the use of compressed air, but that was an extravagant mode of getting power. Compressed air is not in itself a motive power, but only a method of applying it, the power being in the steam engine which compressed the air. M. Mékarski found that for every horse-power, effective, obtained in compressed air, an amount of 5 steam HP. was needed, so that the power actually used was only 20 per cent. There appeared to be an error in the Author's comparison of the pneumatic car with steam power. He estimated, for instance, the fuel by steam power at 5*s.* per day, and in the pneumatic car at 2*s.* 6*d.*, whereas if M. Mékarski was right, it should be five times as much. A combination of compressed air and steam had been brought under his notice, the power being obtained by the explosion of ordinary coal gas. It seemed ingenious and likely to prove of value. It avoided all the difficulties arising from noise, smoke, and the like, and was always perfectly at command, since it could be varied almost at any moment from 2 HP. to 20 HP. Although gas, as fuel, was expensive, he thought the expense would be far more than counterbalanced by the great advantages that would be obtained.

Mr. A. M. Fowler said, in Salford 22 miles of tramway were being laid down, and great anxiety had been felt as to the best mode of construction. He was surprised to find that the Author had come to the conclusion that a timber foundation was the best for large towns. With regard to side fastenings, he agreed with the Author, that unless the paving stones were brought close to the iron the necessities of the case in regard to heavy traffic in large towns could not be met. In Salford a system had been adopted to which the objections raised in the Paper were not applicable. There was a deep flange under the rail, a close joint to the iron, and by having a fastening every 3 feet it was impossible that the traffic could produce any detrimental effect upon the surface of the street. The paving setts were bedded in ashes on the top of the concrete, The first portion of the line had been laid about two months, and although the traffic had been heavy there was no crack or break in the joints of the paving. Before the Salford committee decided upon that plan, they had visited almost every town in England where the best-known systems of construction were employed, and, after his report, they came to the unanimous conclusion to adopt that system. The Author had stated that, by having the timber foundation set back from the rail, the fastenings was made flush with the side of the rail. That allowed for the width of the dog, or the fastening, and it allowed for the sett to come close to the rails. In tramway construction the object was to preserve the foundation, and if it was preserved by keeping out the water, vibration was to a great extent prevented. He did not suppose that the setts were grouted, as in London, with lias lime, or, as in Lancashire and Yorkshire, with asphalt concrete; the space would require to be filled up, otherwise the water would get in, and so it would work loose. He thought the asphalt concrete would not adhere so well to timber as it would to iron, and that continuous bearing was objectionable. If the vibration of the rail was to be reduced to a minimum, the bearings should be about 2 or 3 feet apart. In the old plan of railway construction, with longitudinal timbers, the vibration in the foundation had been so great that transverse sleepers had been resorted to. If such sleepers were laid solid throughout, the structure would not be so good. With a rigid longitudinal foundation packed hard in the centre, it must necessarily tilt, just as a flag in a street would when not bedded well at the corners. He did not wish to say anything against a continuous iron bearing, or a foundation of iron under a portion of the setts; but he maintained that if there was not a uniform foundation for the setts they would tilt. He had found that to be so in tramways already constructed on that principle. Railways were generally level, as compared with tramways, the latter having to be regulated according to the inclination of the streets; and he did not think it would be safe to construct tramways of steel where the gradients were as steep as 1 in 20. On that ground he had adopted the old iron rail. He did not agree with the Author that the fastenings of timber should be more numerous. If the fastenings by dogs were numerous, there would be a tendency to split the timber, and the wear would not be so permanent.

Mr. Livesey described a road that had been largely used in South America, composed entirely of iron and steel. Seven years ago he designed for Buenos Ayres a tramway in which the rail was of steel, and the channel dovetailed, so that the fastening would not project and interfere with the stones. More than 100 miles had been sent to South America, and laid down in the interval. In Buenos Ayres the timber roads were being taken up and relaid with iron roads, which were much more durable, and in the end more economical. He greatly preferred steel rails to iron rails whenever the capital could be offered, as the former did not wear so soon; indeed some of the iron rails had already been renewed. He believed that an iron permanent way would ultimately supersede the use of timber, and that an iron road with a steel rail would last thirty or forty years if not longer.

Mr. J. H. Lynde remarked that the traffic on tramways was different from that upon railways, and that the pavement abutting upon the rail was subjected to much extra wear and tear by the ordinary traffic. Thus it was important that this part of the pavement should be provided with such a foundation as would prevent the subsidence of the setts, which had proved to be the great objection to the introduction of tramways. As the pavement was practically rigid, so the materials used in constructing a tramway should be rigid; moreover the materials should not be liable to decay. The tramway adopted in Manchester fulfilled these conditions. The foundation was a continuous series of cast iron bearers provided with side flanges for the support of the adjacent setts, and a deep groove on the upper surface for the reception of the tongue of the steel rail, which was keyed down by means of wedge cotters passing through the cast-iron bearer and the tongue of the rail. No difficulty had been experienced in laying the tramway, and as much as 220 lineal yards complete had been executed in one day by a gang of sixteen men. The cost of this system, which was known as "Barker's Patent," varied from about £2,000 to £2,300 per mile, according to the weight of metal and depth of pavement used. The Manchester line consisted of 212 tons of cast-iron bearers and 63 tons of steel rails to the mile of single line. One great advantage of this tramway was, that the rails could be renewed with but little interference with the cast-iron bearers or the pavement, and, also that the delay and difficulty of using concrete were avoided, except in rare instances of soft foundation.

Mr. Lawford agreed with the views of the Author, with one or two exceptions. He had stated that asphalt and wood paving had always proved failures. On the south side of London there was a tramway the first 400 yards of which were paved with asphalt. There were stone setts on each side of the rails, and also at 18 inches outside the rail where it joined the macadam; and it was as good a piece of tramway as could be seen. The mischief arose where the asphalt joined the macadam, and there was a series of ruts. The same remark applied to wooden pavement. About 200 yards of similar tramway, near Chapham Rise, were paved entirely with wood, for the purpose of deadening the sound in front of the Home for Incurables. Whatever the pavement was, it should, he thought, be carried across the road; and in that case as good a job might be made with wood or asphalt as with stone. The only other matter on which he disagreed with the Author was with regard to cost. He should like to see a street tramway made for £1,500 a mile. He had made the Duke of Buckingham's tramway, which was not, strictly speaking, a street tramway, but it crossed wide public and turnpike roads. It was 8 miles in length, and had been in existence nearly seven years. The rails, weighing 30 lbs. to the yard, were laid on longitudinal sleepers and the gauge was 4 feet 8½ inches. For the first twelve months it was worked entirely with horses, and since then it has been worked by steam, which had proved more economical. Two of Aveling and Porter's traction engines had been built for the purpose, fitted with flanged wheels, and they had acted extremely well. The speed was from 4 to 8 miles an hour, the average being about 6 miles. Within the last six months a small four-wheeled coupled locomotive, rather lighter than a traction engine, had been introduced. The manager of the line had informed him that the cost of haulage by horses was £1 12*s.* 11*d.*, as against £1 by steam; adding, "in my desire to be impartial, I think I have rather underestimated the cost of horse haulage." The maintenance of the line, exclusive of renewals, was £63 7*s.* 6*d.* per mile per annum. The steepest gradient was 1 in 45 for about ¼ mile; the others were easy, practicable gradients. It was a single line with sidings, and was made at a cost slightly under £1,400 per mile, when rails were rising considerably in price. No mention had been made of the internal dimensions of the cars. On the south side of London the directors tried to pack eleven people inside. He thought there should be a division into two classes, as on the continental tramways. A premium had been offered by the General Omnibus Company for the best method of checking the fares. He did not know whether a mechanical mode of checking the takings of conductors was possible; but a move had been made in that direction in the south side of London; one uniform fare was charged for any distance, and as each ticket was punched, a little piece of paper fell into a box (not under the conductors control) with the operation.

(*To be continued.*)

PUBLICATIONS RECEIVED.

A List of Writings Relating to the Method of Least Squares, with historical and critical notes. By Mansfield Merriman, Ph. D., New Haven, Connecticut, November, 1877.

Proceedings of the Institution of Civil Engineers. The Main Roads of South Australia.—Chas. Townshend Hargrave, A. I. C. E. On Foundations: by Jules Gaudard, translated from the French by L. F. Vernon-Harcourt, M. A., M. Inst. C. E.

Harpers Magazine for December contains:

Milton's Hymn on the Nativity. "Many Leaves and Few Grapes;" A Story.—Virginia W. Johnson. Elizabethan and later English Furniture.—Harriet Prescott Spofford. Back to Back; A Story of To-day [Concluded] —Edward Everett Hale. A Memory; A Poem.—A. J. Requier. The Metropolitan Newspaper.—William H. Rideing. Monmouth; A Poem.—James T. Fields. Master Robby's Romance; A Story.—Henietta H. Holdich. To a Friend who Slept Ill; A Poem.—Edgar Fawcett; Keramos; A Poem.—Henry W. Longfellow. The Man in the Cage; A Story.—Rebecca Harding Davis. A Year of American Travel.—Jessie Benton Fremont. My Uncle's Heiress; A Story.—Charles DeKay. Jamrach's.—M. D. Conway. The Daily Advertiser; A Story; Horace E. Scudder. Da Capo; A Story; Part I.—Miss Thackeray. Was it Love or Blindness?—A. P. C. The Cosmogony of "Paradise Lost."——E. S. Nadal: Editor's Easy Chair: Editor's Literary Record: Editors Scientific Record: Editors Historical Record: Editor's Drawer.

The new engine at the Lake View, Ills., water works is now running, after being inspected and tested by the committee appointed by the Village Trustees, a few days since, a report of which will be presented at the next meeting of the board. The average quantity pumped daily is 320,000 gallons, and the new pump does this work on one-half ton of screenings daily. The pressure test will be made at some future day.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER-WORKS.

The new gas company of Harrisburg, Pa., has already laid pipe to the extent of fifteen miles.

The time for receiving proposals for the Johnstown, N.Y., water works is extended until 12 o'clock noon, of Tuesday Nov. 27.

The gas companies of this city have accepted the terms of the council of $1.65 for the South side, and $2.00 for the West side per 1,000 feet.

The artesian well at Anamosa, Iowa, has been abandoned at a depth of twelve hundred feet. Three thousand dollars were sunk in the enterprise.

The Perth, Iowa, Council have as yet made no other move in the way of getting water works, and it is not probable that it will at present adopt any such scheme, but may possibly buy a steam fire-engine. A large expenditure is expected to be made as a bonus to railways and water works stock is in consequence at a discount.

The Montreal, Ottawa & Occidental R. R., is being pushed rapidly forward, and hopes are entertained of passenger trains being run between Ottawa and Montreal by December. Already the track has been laid as far as Gatineau Point, opposite this city, and construction trains are hard at work. All the railroad depots are in progress of erection.

RAILROADS.

The foreclosure sale of the New York & Oswego Midland R. R· has been again postponed, until January 11, 1878.

The Grand Trunk R. R. company have purchased the Michigan Air Line railroad, which is to be immediately extended to Chicago.

The Waynesburg & Washington, O., narrow-gauge R.R. is completed, and the citizens of the two towns are making preparations for a jubilee.

The Southern Pacific R. R. company has now on the ground ties for 600 miles of road from Yuma toward the Atlantic States.

The C., R. I. & P. R. R. Co., has purchased the Peoria & R. I. R. R., at a total cost of little less than $800,000, the object being to cut of competition at Rock Island.

The Utah Northern R. R. is cross-sectioned about nine miles, and jobs are being let; track-laying will commence in about two or three weeks.

The tracklayers on the Pittsburgh, Wheeling and Kentucky R. R. reached Wellsburg lately and expect to have the rails laid to Wheeling some time next month.

Five hundred tons of steel rails have been received for the northern extension of the Des Moines and Minneapolis narrow gauge R.R. from Ames, Iowa.

William N. Whiteley has been elected president of the Springfield, Jackson & Pomeroy R. R., Ohio, and the general offices of the road are to be removed from Greenfield to Springfield at once. A vigorous prosecution of work is expected.

Rapid transit has gained another victory in New York. A suit was lately brought against the New York Elevated Railroad company, to restrain them from building their structure on what is known as the East Side, in front of certain premises on Front street. When the action was commenced a temporary injunction was obtained. Judge Robinson, at the special term of the Court of Common Pleas, has just rendered a decision in favor of the company. He holds that it has a perfect right to continue its work, and accordingly dismisses the complaint. It is quite evident that rapid transit will be an accomplished fact in the metropolis at an early day.

The annual statement of the condition of railroads in Great Britain for 1876 affords some interesting points of comparison with roads of the United States. There are only 16,872 miles of railway in Great Britain, the addition for 1876 having been 214 miles. The number of miles of road in the United States is 77,000—more than four times the number of miles in Great Britain. In the latter country there is one mile of road to every 2,000 persons. In this country there is one mile of road to every 533 persons. The first reflection suggested by this is that Great Britain is very insufficiently supplied, and the United States very well supplied with railways. But there are other facts in the comparison which show that Great Britain possesses about all the railways it needs, while we possess more than can be run at a profit and therefore, more than we really need. The total nominal capital of the 16,872 miles of British railways, including stocks and loans, is $3,290,000,000, while the total nominal capital of our 77,000 miles is about $4,500,000,000. The capital of British railways represents an average cost of about $190,000 per mile, while that of our railways represents an average cost of about $53,000 per mile. The gross earnings of the British roads for 1876 were $310,000,000, or $18,440 per mile, and their net earnings $142,000,000, or $8,666 per mile; the gross earnings on our roads were $497,000,000, or about $6,600 per mile, and their net earnings $186,000,000, or $2,415 per mile. Our 77,000 miles of road earned more than a half more, gross, than the 16,872 miles of British, but the net earnings of the British roads were nearly four times as great to the mile as ours. The percentage of operating expenses in Great Britain is 54 per cent of the gross earnings; in the United States it is 69 per cent.

The Atchison, Topeka and Santa Fé engineering party, in charge of W. R. Morley, says the Cimmaron News and Press, passed here to-day en route for Las Vegas, where they begin surveys southward and southwest toward the Rio Grande and lower country. We do not know how far south they intend to go, but rumor says to the thirty-second parallel, somewhere on the line of the Texas & Southern Pacific roads. The party expect to be absent some months. During the past season they have been at work on the passes westward from Pueblo and Colorado Springs towards the head of the Gunnison river, as also has another party under H. R. Holbrook, who proceeded westward on that route, while Morley's party came back to run south and southwest through New Mexico. Of late this party has been at work in Raton Pass and we learn found a practicable line across the Raton Mountains there. Former surveys by Mr. Morley also developed practicable routes in New Mexico, via the Dry Cimarron and Long's canon routes so that the Atchison, Topeka and Santa Fe company have three available routes which they can select from. Appearances are that the Atchison, Topeka and Santa Fe company intend shoving right along, and we may responsibly hope that within a short time another trans-continental line will reach across the continent via New Mexico and Arizona.

India can boast of some of the best managed railways in the world, as far as financial success in the test of good management. The returns of last year show that the East India railway has yielded nearly seven per cent. clear profit on a capital of £30,500,000. The gross receipts were upward of 3,000,000; the working expenses about a third of that sum. The East India railway has thus beaten all the English lines, some of which, by means of the favorable terms on which they have raised debentures and guaranteed stock, have been able to squeeze out a dividend at that, or somewhat higher, rate to the holders of a third of their capital. The Great Indian Peninsula railway, also, has returned to the government, by way of surplus profits, as much as £340,000, out of the £3,000,000 sterling that has already been repaid of the interest advanced under guarantee. The effects of railways in improving the wages of the laborer in India, and in raising his position both in the physical and in the moral scale, have been both direct and indirect. The native artisan works side by side in the shops with the English workmen, and shows himself no unapt scholar. The low cost of the locomotive power on the East India railway is due not so much to the low cost of native coal (which is less per ton than is paid by any English railway) as to the fact that native drivers, firemen and attendants are employed to a great extent by the company. The difference in wages is more than that between shillings and pence; and the fact that native Indians can be safely entrusted with such responsible duties is one that is most significant as to the future course of the labor market in India, and elsewhere, so far as it is affected by Indian competition. It is also matter for extreme satisfaction to find that the natives are obtaining sufficient confidence to invest their own capital in making Indian railways. The Nizam, Holkar, Scindia and the Gaikwar have come forward. With the assistance and under the guarantee of the government, to provide the necessary capital for railways in their respective states. Still more encouraging is the provision of capital from provincial and local sources.

The Trans-Pacific Cable Company, for laying a telegraph cable from San Francisco to Japan and China, via the Hawaiian Islands, organized Nov. 14. President, Leland Stanford; Vice-Presidents, Celso Cæsar Morens and John T. Miller; Secretary, A. S. Hallidie; Treasurer, Mark L. McDonald; Directors, George S. Dodge, William Norris, Eugene Sullivan, William Irwin, O. H. Lagrange, D. L. McDonald, William Simon, Frank Pixley, N. K. Masten, all of California; Henry O'Reilly, of New York. James C. Flood was elected Director, but has not yet signified his acceptance. The capital stock of the Company is $10,000,000, in shares of $100 each. Vice-President Morens will leave in a few weeks to secure the necessary franchises from the Hawaiian, Japanese, and Chinese Governments.

FLORIDA NOTES.

The projected railroad from Waldo to Orange Lake, Fla., has $80,000 of stock subscribed and is in a fair way to be finished this winter.

Experiments made with lime made from the Coquina or Shell rock of Florida show it to be equal to if not superior to the best cement. Its qualities are extreme hardness and durability. It does not scale but it sets slowly.

Truly yours,

J. FRANCIS LEBARON, C. E.

CONTRACTORS.

The firm of Hotchkiss & Gaylord, Cleveland, Manufacturers of machine, bridge, track, plow and elevator bolts, etc., have received heavy orders from Canada for bolts for railroad bridges. On an average they manufacture from 20,000 to 55,000 bolts a day.

Pierce & Rowe of Frankfort, Maine, have obtained the contract to furnish granite for the completion of the New York and Brooklyn bridge, amounting to some $750,000. They will employ some 150 stone cutters and quarrymen, blacksmiths and others.

There was recently quarried without the use of powder, at the Barre granite quarries, for the use of the Oliver Granite Works, of Rutland, a block weighing about six hundred and eighteen tons, being forty feet long, seventeen feet high, and ten feet thick. This immense stone is said to be perfect in every respect, and is believed to be the largest block of granite ever quarried in the State.

Mr. Gowen, of Philadelphia, has just received a cable telegram from London announcing the execution of the contract there between the Madeira and Mamoré Railroad Company (Limited), The National Bolivian Navigation Company, and Messrs. P. & T. Collins, contractors, of Philadelphia, by which the latter agree to complete the grading, masonry and superstructure, and furnish the equipment of the railroad of the first-named company. This road is projected from the present head of navigation on the Maderia River, a branch of the Amazon, in Brazil, to Bananeira Falls, on the Mamoré River, on the borders of Bolivia, and is about 180 miles long, embracing the falls and rapids, which now render navigation impracticable. It is designed as a narrow-gauge road, with iron rails of 45 pounds per yard, and will be used to transport the products of the Atlantic slopes of the Andes to the navigable waters of the Madeira River and thence down the Amazon. The Philadelphia and Reading Coal and Iron Company will supply all the rails and other ironwork and materials that will be required to construct and equip the road. This is a first and most important opening of trade between this port and Brazil. The equipment will include locomotives, cars, rails, spikes, bolts, chairs, turn-tables, &c., and the total cost of the road is said to be $5,000,000. The payments to the contractors will be about three-quarters in cash, for which the money is now in hand, and the remainder in the debentures of the railway company, guaranteed by the Brazilian Government. The Philadelphia and Reading Coal and Iron Company will receive immediate cash payments on shipment of the materials from the port of Philadelphia.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society, Associate of the Institution of Civil Engineers.

ADDENDA.

Continued from page 276.

It will perhaps be well to consider the question of American and English bridges somewhat more fully. One of the usual arguments against pin connections is that they, when subject to vibration, cut into the iron and *vice versa*. Examples from practice are not wanting in which such has been actually the case. Bridges which were originally designed and erected with pin connections and which have since required rivetting might be quoted, but these so far from tending to verify the supposed inferiority of pins merely indicate ignorance on the part of the designer of the proper proportions to give to pins and eyes.

It has already been pointed out by Mr. Clanchy in the discussion that bridges on the American system have a decided advantage in new countries on account of the small weight of the various portions and the speed with which they can be put together. It is no uncommon circumstance to find American engineers speaking and writing of putting up spans of 150 feet to 250 feet in from two to four days. According to Mr. Lovett, chief engineer to the Ohio and Mississippi Railway, the last span of the Medora Bridge built for that company over White River, and measuring 147 feet 6 inches between centre and centre of end pins, was erected by four foremen and thirty-seven men in one day. In England a few weeks more or less for the erection of a bridge is not generally a matter of great moment, but for foreign work speed is often of paramount importance, as their streams which can be walked across dry-shod one day are in the space of twenty-four hours converted into roaring torrents capable of washing away both the temporary staging and the girders in course of erection upon it. Another advantage of speed in construction in foreign countries is the fact that the new road is often the only means of communication with its own more advanced portions, and until a certain bridge be constructed it may be difficult to convey materials for the advancement of distant works. There is a further consideration which may even make it desirable to introduce this class of bridge into England, namely, that nearly the whole of the work in the construction is performed by machines, and the erection may be carried on by unskilled labor directed by competent foremen. These are matters worthy of some attention in these days of strikes and inconsiderate and arbitrary restrictions imposed upon labor by various Unions. For instance the day's work of a boiler-maker allowed by the Boilermakers' Club can be put in by twelve or one o'clock by a good average man working piece-work. This of course much enhances the value of rivetted work, and it therefore behoves engineers to reduce as much as they consistently can the number of rivets in their bridge designs.

Touching upon the question of the comparative cost of the two systems, under normal conditions it may be roughly said that there is little or no economy in using pins in spans of less than 130 feet, or 140 feet, as although the bridge may possibly be of less weight the price of the ironwork per ton is enhanced. It is often desirable when dealing with heavy moving loads accompanied by a greater or less amount of vibration, to reduce the workmanship and increase the weight of the bridge in order to lessen the disparity existing between the weight of the structure and that of the moving load coming upon it. In such cases, as for instance a short span railway bridge subject to the traffic of heavy engines, rivetted work may be employed with advantage. However in bridges of say spans over 200 feet in which the weight of the structure bears a large proportion to that of the moving load, it will no doubt be found advisable ultimately on the score of economy and policy to follow somewhat more in the track of our American brothers, more especially when a large number of similar spans are required.

The following tables, No. 1, 2, and 3, have been abstracted from a paper read at the fourth annual convention of the American Society of Civil Engineers, held at Chicago June 5th and 6th, 1872, by Messrs. John Griffin and Thomas C. Clarke, of the Phœnixville Bridge Works, Philadelphia. These statistics of American bridge construction cannot fail to be of interest representing as they do the practice of a large transatlantic bridge firm.

TABLE NO. I.

Actual Weights of American Engines and Rolling Stock.

Description.	No. of Driving Wheels.	No. of Truck Wheels.	Concentrated weight on drivers divided by length of driving wheel base.	Resulting weight per foot.	Total weight of engine and loaded tender divided by distance covered on track, including pilot.	Resulting weight per foot.
Class No. 1.—"Pushers."						
Reading Railway Tank, all	12	None.	102,000 / 19ft. 7in.	5,204	102,000 / 36ft. 0in.	2,833
Reading Railway Tank, with Tender	10	"	82,200 / 15ft. 8in.	5,268	132,200 / 54ft. 1in.	2,448
Pennsylvania Railway, with tender	8	"	80,000 / 22ft. 0in.	3,636	140,000 / 54ft. 0in.	2,595
Baltimore and Ohio Railway, with tender	8	2	84,000 / 12ft. 6in.	6,720	128,000 / 53ft. 0in.	2,415
Fairlie, double-ender	12	None.	60,480 / 8ft. 0in.	7,560	120,900 / 52ft. 0in.	2,326
Class No. 2.—Heavy Coal and Freight.						
Chicago, Burlington & Quincy, freight	6	4	72,000 / 12ft. 0in.	6,000	128,000 / 53ft. 6in.	2,392
Reading, standard coal	6	4	53,000 / 9ft. 6in.	5,578	122,128 / 50ft. 3in.	2,430
Pennsylvania, standard freight	6	4	54,500 / 12ft. 5in.	4,360	129,900 / 54ft. 0in.	2,405
Delaware, Lackawanna and Wilmington, standard freight	6	4	71,500 / 12ft. 0in.	5,948	158,900 / 54ft. 0in.	2,572
New York Central, special freight	6	2	65,000 / 15ft. 6in.	4,193	120,000 / 45ft. 0in.	2,666
Erie Broad-gauge, special freight	6	4	72,156 / 15ft. 6in.	4,976	137,444 / 54ft. 0in.	2,545
Class No. 3.—Mixed Passenger, and Freight and Passenger.						
Reading, mixed passenger and freight	4	4	41,440 / 6ft. 6in.	6,376	115,184 / 45ft. 7in.	2,526
Reading, standard passenger.	4	4	25,264 / 6ft. 6in.	3,887	103,260 / 43ft. 10in.	2,325
Pennsylvania, standard passenger	4	4	45,400 / 8ft. 0in.	5,675	125,300 / 53ft. 6in.	2,342
Grand Trunk of Canada, standard passenger and freight	4	4	40,320 / 7ft. 6in	5,376	112,000 / 49ft. 0in.	2,275
New York Central, standard passenger and freight	4	4	40,000 / 7ft. 6in.	5,460	100,000 / 44ft. 0in.	2,272
Average of loaded tenders	..	8	16,500 to 25,000 / 4ft. 6in.	3,666 to 5,550	33,000 to 50,000 / 20ft. 0in.	1,650 to 2,500
Class No. 4.—Loaded Cars.						
Pennsylvania Railway, sleeping and passenger cars	..	..	..	..	57,000 / 64ft. 2in.	890
Pennsylvania Railway, box freight cars	..	..	..	..	42,000 / 31ft. 0in.	1,355
Reading long coal cars	..	..	..	..	40,000 / 22ft. 0in.	1,818
Lehigh Valley, short coal cars	..	..	..	..	19,000 / 13ft. 0in.	1,461
Pulman palace and sleeping cars	..	..	..	..	71,600 / 75ft. 0in.	954

TABLE NO. II.

Weight in lbs. for different classes of trains on various spans. Per foot run of span.

Length of span in feet.	All locomotives.	Coal train, cars (No. 20) drawn by two engines (No 7.)	Coal train, cars (No. 20) drawn by one engine (No. 7.)	Freight train, cars (No. 19) drawn by two engines (No. 8.).	Freight train, cars (No. 19) drawn by one engine (No. 8.)	Passenger train, cars (No. 22) drawn by one engine (No. 16.)	Dead weight of single line railway bridge, track, rails, etc. Per foot run.
Feet.							
Under 12	5,000	..	..	..	..	..	500
12 to 17	4,000	..	..	..	..	..	550
17 to 25	3,500	..	..	..	..	..	625
25 to 83	3,000	..	..	..	..	..	750
83 to 100	2,500	..	..	..	..	..	870
110	..	2,430	2,094	2,405	1,870	1,481	1,000
125	..	2,365	2,067	2,262	1,809	1,418	1,135
150	..	2,275	2,026	2,111	1,740	1,340	1,225
175	..	2,200	2,000	2,065	1,710	1,285	1,300
200	..	2,130	1,974	1,922	1,665	1,244	1,500
225	..	2,100	1,950	1,864	1,631	1,211	1,700
250	..	2,068	1,943	1,809	1,603	1,186	2,000
300	..	2,026	1,922	1,733	1,562	1,147	2,400
350	..	2,000	1,907	1,679	1,532	1,120	3,000
400	..	2,000	1,895	1,638	1,510	1,100	4,000

(*To be continued.*)

CANADIAN TRUNK LINES.

Our esteemed contemporary, the *Railway World*, is usually quite sane, but in the issue of the 15th inst. an editorial entitled "Canadian Trunk Lines," suggests a policy so foreign to all ideas of national comity, so blighting to all trade relations between Canada and the United States, present and prospective, so narrow, selfish and proscriptive, that we prefer to ascribe it rather to the machinations of the trunk lines interested than to any temporary aberration of mind on the part of the editor. We hardly consider the article worthy the attention which we shall give it, did we not believe its influence vicious on that numerous class who never think farther ahead than to-day, caring only to obviate present annoyances, and always accepting without question the views of their narrow political paper, and swinging them on all occasions as their favorite shibboleth. When the views of such political organs creep into a professed technological journal they become more than ordinarily insidious, and should be combatted with far more force than they deserve.

The article in question recites that of the three great Canadian lines, Grand Trunk, Great Western and Canada Southern, the first two are controlled by English capitalists and compete for foreign trade through Montreal with all the trunk roads, and for the trade of New England with the New York Central in particular. The effect is to cause a cutting of rates by the New York Central followed by the other trunk lines in turn, all going down like a row of books set on end when the first one is hit. This, of coure, is more or less detrimental to the interests concerned, and the Canadian lines can determine to a certain extent the profit of our own East and West lines. It farther states that while the traffic is derived from this country, the control, profit, labor, material, etc., is vested in Canada or England, beyond the reach of enlightened American statesmanship, and asks why, if the traffic was confined to our own lines, it could not be done cheaper, to the mutual profit of both railways and their customers, and suggests that Congress legislate on the subject, and prophesies that the great patient American people will not always stand in their own light, but will soon find a remedy which will be effective.

Whatever may be said of the theory of protection within its legitimate sphere, this certainly is carrying it to absurd limits. The idea of one nation passing proscriptive laws against the railways of another country is, we apprehend, something new in modern legislation. Canada to day is one of our best customers. The balance of trade is twelve to fifteen millions in our favor. An American firm built the greater portion of the bridging on the Intercolonial, and other bridge firms are doing work in the Dominion every year. The *Railway World* should know that a large portion of their railway supplies come from our firms, and that they are growing customers of all our manufactured products. The great bulk of these trade relations has grown up in spite of a protective tariff. Give us reciprocity with Canada and our trade relations with her would expand enormously, and those feelings of comity, which have already taken so firm a root in the two countries, would grow and unite us in one nation.

Every one remembers when to go to Canada was like going to a foreign country. Customs, habits and sympathies were different. To-day she seems an integral part of this commercial union, and in our business relations with her we think of and treat her as one of the states of this political Union. Our contractors are taking a large part in the building of her public works, and even now our capital is inaugurating for her railway enterprises, and pushing them to completion. Vanderbilt & Schell control what is destined to be her most important through line, the Canada Southern. Great Western is run and controlled chiefly in our interests, and those same interests must yet place it in our hands. Lesser bodies are attracted to, and their orbits are controlled by, the greater. Canada's interests are ours, and must be adapted and controlled by our interests. Our energy is ramifying through her innermost recesses, and her substance is becoming assimilated by this commercial union. Is it wise to place any obstacle in the way, to do anything to drive asunder these gradually uniting countries?

If Congress were to pass an act laying an embargo on produce passing from one part of the Union to another over Canadian lines, or passing from the Union through Canada to a foreign market, Canada could easily make reprisals. All the Eastern States would feel the loss of her lumber. American shipping would be, by proscriptive legislation, practically excluded from the Welland Canal, which Canada is spending twenty million dollars to make available for large vessels, and also from the St. Lawrence canals, on which she is spending much more. The great West is directly interested in these water lines, as she expects to send her grain to the seaboard by them at 6 cents per bushel in place of the present 15 to 30 cents. The Washington treaty, with wise statesmanship, secured these to us on equal terms with the Canadians; but these terms could not hold were we to adopt a proscription policy. Such a policy continued would destroy our cordial relations, and draw out of Canada our enterprise and our lucrative trade in manufactured products, much to our own detriment. Doubtless our trunk lines would be benefited and the *Railway World* pleased. But that would be a small return for the loss of existing interests in both countries. The producer and consumer also have rights which we are bound to respect. Doubtless the *Railway World* would advocate the shutting up of our canals and the destruction of lake commerce in order that the railways might be benefited. The *Railway World* had no sympathy to waste on the Grand Trunk when our own lines were cutting below paying rates and scarcely a consignment was made to Montreal. Now the shoe is on the other foot.

The truth is that our trunk lines have twice as much carrying capacity as the traffic needs or will need for some time to come. New York Central has four tracks, with no more necessity therefor than a wheel-barrow for four wheels. All the other trunk lines can carry double their present traffic under proper train systems. The railway companies, of course, desire a dividend on these unnecessary expenditures. If we had governmental control of railways, as in France, the development of these trunk lines could be restricted to the traffic requirements. But under our system of government this is clearly impossible. Competition, and the more the better, has been the continual cry of the American people, and they have always been exceedingly jealous of any legislation looking to its restriction. But they have learned, or will learn, that railway competition always ends in combination and pooling of earnings. Grand Trunk refuses to enter the combination, and being, for the time, outside of American influence, proscriptive legislation is suggested against all Canadian railways. Of course the failure of the Canadian lines to compromise is sufficiently aggravating to our trunk lines.

If the Canadian lines were proscribed, would it help matters? Almost every year sees new combinations effected, a few short links built, and a new and independent line from the West to the seaboard opened. This cuts rates for a time to get a portion of the traffic, obtains a recognized position among the trunk lines, and is forthwith swallowed up in the pool. These combinations with trunk lines are made largely to save old investments or to increase the value of new. Cities encourage them in the hope of competing outlets, and ultimately reap the benefit in paying interest on greater capital. If the Canadian lines were excluded, doubtless our lines would reap a temporary benefit. But that moment which declared a good dividend on the capital invested, would see new trunk lines inaugurated. It would not be beyond probability to say that a half dozen new trunk lines from the West to the seaboard would be under way in ten years.

While we have no unfriendly feeling toward the railways, and do not advocate restrictive legislation of any kind, except so far as to give all parties a "fair show," we must recognize that there are other interests to be considered. The shipper, the producer and consumer represent interests, largely dependent on railways, it is true, but far transcending them in value. None of these desire, or will permit any one to say where or by what lines products shall be sent. Canada derives a large portion of her food supply from the Northwest, and sends her lumber and other products in return. The Northwest will insist on sending her supplies through the Canadian door to foreign ports if she can save money by it. We are too much interested in all the available outlets to listen with patience even to the suggestion of closing any one of them.

THE Milwaukee Bridge and Iron Works are to be sold next month under order of the court. Total indebtedness, $520,000.

TWENTY strands of the main cable of the East River Bridge are now completed and in position, and work on the approaches is progressing rapidly.

THE Michigan Ship Canal project, from Lake Michigan to Lake Erie *via* the Kalamazoo Valley, is again being agitated,—a meeting being held at Allegan, Mich., on the 16th inst.

THE Phœnix Iron Works, the Keystone Bridge Co., and the Edgemoor Iron Works have each the contract for a section of one mile of the Gilbert Elevated Railway of New York City.

THE recent railway accident near Des Moines, Iowa, was caused by a culvert wash-out. This culvert was built on short piles and the water washing away the earth which supported them they of course toppled over like a row of brick. It would seem advisable to drive headings of sheet-piling on similar constructions. There seems hardly any excuse for the wash-out of a properly designed culvert.

THE chief engineer of the Atlantic & Pacific, originally intended to reach the Pacific coast on or near the 35th parallel, has been making a reconnoisance southwest from Vinita, 430 miles to a junction with the surveyed line of the Texas Pacific at a point called on the maps, Sulphur Springs. It is the intention of the company to build this line and abandon the Pacific project which we imagine was never adequately considered.

THE St. Louis papers are growling about "that stupendous fraud in the way of government improvement called Horse-Tail Bar, just below St. Louis." The St. Louis *Globe-Democrat* makes it a text for lashing the government engineers, apparently recommends the relegation of all government improvement to private enterprise, and puts up Capt. Eads as an illustration of how the thing can be done skilfully, effectually, and at the least expense.

TORONTO and Ottawa have been for some time agitating for direct railway connections and the towns along the route are favorably disposed toward granting bonuses. This will no doubt run through a favorable country for local traffic and in connection with the North Shore line will form a favorable competitor to Grand Trunk to Quebec, and other eastern points. The negotiations have so far progressed that the road will doubtless be built at no distant day.

GENERALS GILMORE and DUANE, of the Engineer Corps, have finally concluded that the Washington monument may be completed on its present foundations if certain additions be made thereto. These additions are to consist of a strong wall built entirely around the foundations six feet from the corners and twelve feet from the middle of the sides, and sunk twelve feet below the present foundation, the space between the wall and the old foundation to be filled in with a strong concrete of rubble and cement.

FIVE hundred men are at work on the Brooklyn, Flatbush & Coney Island R. R., under the direction of the Engineer of the road, Mr. Charles Crooke, of Flatbush. This road is a double track and has some interesting and expensive work on its line out of Brooklyn, and it is intended to place upon it pavilion cars to accomodate the rapidly increasing summer excursion travel. These cars will run at forty miles per hour, reaching Coney Island in twelve minutes. Prominent capitalists are backing it, and it will be pushed to completion by June 1st.

A RECENT letter to the *Scientific American* in its promises transcends the remarkable. It appears that the electrician, Mr. T. A. Edison, has produced an apparatus, on principles similar to the telephone, which permanently records on a slip of paper the sounds of the

human voice so that they can be reproduced by an other apparatus at any future time. This he expects to perfect within a year. Can we conceive anything more wonderful, and yet in its scientific aspects it is comparatively simple. Words may well fail to describe the possibilities of such an invention.

We note in an exchange the following figures, which may serve as food for reflection: In 1863, when steel rails were first made on orders in this country, their average price was $158.50. In 1873 the average price was $120.50, and that of iron rails, $76.66⅔. Steel rails are now quoted at $44 to $45, and are sold for less. Let engineers collect statistics in other branches of manufactures and have an intellectual tournament as to the policy of Protection *versus* Free Trade. Careful consideration of the facts by that large class of competent scientific men interested in manufacturing interests, might result in a public opinion which would produce a healthful effect on the average "statesman."

New through routes from the West to New England are in embryo, in which the Pennsylvania Central and New York & Erie will share with New York Central the growing traffic of the eastern cities. These old roads propose to utilize the Delaware & Hudson canal lines as far as feasible. Taking the line from Binghampton to Schenectady, a new line will branch off from the Saratoga road, a few miles out of Schenectady, cross the Hudson on a high bridge at Mechanicsville and join the Troy & Boston at Eagle Bridge and thence by the Hoosac Tunnel route to Boston and other points. From Schenectady east to Boston the line is more favorable than either of the existing routes the distance to western points is not materially greater. The intermediate link crossing the Hudson at Mechanicsville is now under construction.

A bill will probably soon pass the Mexican Congress authorizing the construction of the Sonora railway. This road is to start from the fine harbor of Guaymas, on the Gulf of California, running, for the most part through a continuous valley, crossing the Sonora river at Hermosillo (the beautiful city) and terminating at some point in Arizona (probably Tucson) on the proposed line of the Southern & Texas Pacific. The line has no tunnels and only one bridge, over the Sonora river, and is very easy. The money is already supplied by Eastern capitalists, and construction only awaits a settlement of the Diaz troubles. Sonora is very rich in agricultural and mineral wealth, which will soon have an outlet to California by Southern Pacific soon to reach Tucson, and Guaymas is also the nearest Pacific port by Texas Pacific from St. Louis and other points. The investment of capital in Sonora and neighboring states by Eastern men, and California's direct interest in these states will account for much of our international complications.

We notice from the New Orleans papers, that the subject of the drainage of that city is again attracting attention. In our issues of May 5th, and 12th we published an article illustrated by a map, descriptive of the project begun in 1871, and on which up to 1874, about two million dollars had been expended. The scheme, however, originally estimated to cost three millions, had not reached that point at which a proportionate advantage to the expenditures made could be reaped, and to render the present work available, much additional money is required, which the nearly bankrupt city of New Orleans can hardly expect to raise. As a consequence the placing of the back levee on the Metairie Ridge is again advocated as giving quickest and cheapest relief. This is again opposed by a majority of the engineers and physicians interested as it leaves a large malarious swamp between the ridge and the lake undrained. The works commenced in 1871 under the carpet-bag regimen have much the odor of jobbery and many imperfect constructions were adopted, as for instance, the facing of the lake protection levee with wood lasting only five to seven years. In the New Orleans *Picayune* of October 28th, Gen. G. T. Beauregard has a long letter suggested by a communication of Capt. John Roy, in which he condemns at length all modern structures or combinations of wood and cement. He also asserts that concrete exposed to the brackish coast air rapidly deteriorates and crumbles away, and recommends a protection wall of concrete faced with brick which has stood well in sundry constructions. He also advocates the placing of the back levees at the Metairie Ridge.

Mr. W. H. Bell, the City Surveyor from 1871 to 1874, in a letter to the New Orleans *Democrat* of November 3d, replies to Mr. Beauregard at great length. After giving some history as to the construction of the original works, the wooden facing which he did not approve, etc., he proceeds to combat the scheme of placing the back levee at Metairie Ridge, claiming that it is quite impracticable on account of land damages, not warranted by the future prosperity of the city and unadvisable on account of the undrained swamp. He introduces evidence from physicians and engineers to bear out his statements and gives much information relative to high water on Lake Ponchartrain, etc. One thing is certain,—New Orleans needs to be in much better sanitary condition to occupy the place among the metropoli of this country which she is evidently destined to fill, and money to complete these works, if it can be had, cannot probably be expended more judiciously for her future good.

LIVERPOOL ENGINEERING SOCIETY.

On Wednesday evening, October 24, this Society held its usual fortnightly meeting in the Rooms of the Royal Institution. The President, Mr. C. Graham Smith, A. I. C. E., occupied the chair. Mr. L. Jerome Tisdall, B. A., read a paper on the Water Supply of Towns. His remarks were limited to considering the subject under the three following heads: 1st. A historical sketch of its rise and development. 2d. The Geographical and Hydrographical features upon which the supply depends. 3d. The methods adopted in drawing water from various sources. After referring to the aqueducts constructed in the reign of Solomon, and the water conduits of ancient Rome, and speaking at some length on these deservedly renowned works, he remarked on the singular construction of the ancient wells, more particularly Joseph's well, which he stated was nearly 300 feet deep. The water was raised by oxen walking round and setting in motion, a wheel over which passed an endless rope to which buckets were attached. As the depth was too great for one lift, a chamber was constructed about 160 feet below the surface of sufficient size for oxen to work in, and containing a reservoir into which the water was pumped previous to being raised to the top of the well by the oxen working on the surface. He pointed out that well water derives its characteristics from the strata through which it passes. If it takes up chloride of lime it becomes "saline;" if salts of lime it becomes "hard;" if carbonic acid, sparkling and pleasant to the taste. River water has its quality governed by the character of the surface of the land forming its water-bed. By the aid of a diagram the principle on which the artesian well acts was clearly pointed out, and the amount of water which might be expected could only be estimated after the area covered by the "outcrop," of the strata had been carefully ascertained. The rainfall in England varies from 22 to 40 inches per annum, and the portion of this which may be calculated upon for providing a water supply varies with the nature of the ground on which it falls. With steep rock surfaces nearly the whole may be stored. Moorland and hilly grass land from 60 to 80 per cent.; flat, cultivated land, 40 to 50 per cent. The author concluded his very interesting paper by a brief consideration of the question affecting the supply of water to large towns such as Manchester, London and Liverpool, and a hearty vote of thanks terminated the proceedings.

W. Wilkinson Squire, *Hon. Sec.*

Dockyard, Liverpool.

A self-moving terrestrial globe has been constructed by a Benedictine monk of the monastery of Raigern. Its motion is similar to that of the earth. The delineations of the surface of the globe are very carefully executed, and embrace all the recent geographical studies, including the results of late deep-sea soundings. A smaller globe is attached to it by clock-work, in order to represent the motion of the earth round the sun. At the North Pole there are dials to indicate the day of the month, etc. This model was the result of ten years' labor.

CINCINNATI SOUTHERN RAILWAY BRIDGE AT CINCINNATI, OHIO.

In another column will be found a communication relative to the tests of the Cincinnati Southern Railway Bridge over the Ohio river at Cincinnati. Since receiving the communication we have been favored with a visit from Mr. A. Gottlieb, Superintendent and Engineer of the Keystone Bridge Company, who furnishes us with a table of the results which will supplement the information given in another column. The test lasted four hours and was largely attended by the citizens of Cincinnati, who, as taxpayers, are so largely interested in this enterprise. Among the experts present were A. Gottlieb of the Keystone Bridge Company, C. Shaler Smith of the Baltimore Bridge Company, Vice President Vaughan of the Louisville Bridge Company, President Miles Greenwood of the Board of Trustees, and G. Bouscaren, Consulting and Principal Engineer of the railway.

The spans immediately over the river aggregate a length of 1,480 feet, while the total length of bridge and approaches is 2,393 feet. The bridge proper was built by the Keystone Bridge Company of Pittsburgh, and the Cincinnati approaches by the Baltimore Bridge Company.

The construction of the Cincinnati Southern Railway, principally on account of its being a municipal enterprise, has probably attracted wider attention than any other new road. We are happy to say that this construction has been carried on with great ability, both in structures and permanent way, and reflects great credit on the organization and scientific attainments of its engineer corps. It is eminently a theoretical railway, not built by empyricism, and should the records of its construction, including specifications, &c., along with its history and the considerations which determined the alignment and character of permanent structures, the whole well illustrated, be embraced in a final and carefully digested report, it would be invaluable to railway engineers. Let it be done.

Test of Spans No. 1 to 10, inclusive of Ohio River Bridge. November 8, 1877.

No of Tests.	Span Under Test.	Length of Span. feet.	Dead weight of Span lbs. lin. ft. lbs.	Rolling Load.	Weight of Rolling load on Span. lbs.	Deflection of E. Truss. Under load in inches.	Deflection of E. Truss. Permanent in inches.	Deflection of W. Truss. Under load in inches.	Deflection of W. Truss. Permanent in inches.
2	No. 1.....	110	1258	2 engines coupled.	234,000	11-16	1-16	11-16	3-32
3	S. half draw...	185	2161	4 engines coupled.	413,000	5-8	1-16	Not obs.	..
4	N. half draw..	185	2161	4 engines coupled.	413,000	5-8	1-16	1-2	1-16
5	Entire draw span.....	185N 185S	2161	7 engines coupled.	780 000	11-16	1-16	1-2	1-16
6	Chan. span....	519	5393	7 engines coupled and 4 loaded platform cars.	966,000	2 3-32	3-32	2	0
7	No. 4.....	300	2454	6 engines coupled.	680 000	1 5-8	1-16	1 9-16	1-16
8	No. 5.....	300	2467	6 engines coupled.	680,000	1 9 16	0	1 5-8	0
9	No. 6.....	190 partly curve	1444	4 engines coupled.	416,000	1 1-8	0	1 3-16	1-16
10	No. 7.....	190 on 3° curve	1536	4 engines coupled.	416,000	13-16	1-16	1	1-16
11	No. 8.....	190 on 3° curve	1536	4 engines coupled.	416,000	13-16	0	1	1-16
12	No. 9.....	113 partly curve	1151	2 engines coupled.	228,000	9-16	1-32	1-2	1-16
13	No. 10.....	113	1147	2 engines coupled.	228,000	7-16	0	1-2	1-16
14	Chan. span....	519	5393	4 loaded flat cars followed by 2 engines followed by 25 miles an hour.	393,000	13-16	0	1 3-16	0

STREET TRAMWAYS.*

BY ROBINSON SOUTTAR.

Continued from page 324.

Mr. C. H. Beloe thought the subject of street tramways had not received the attention which it deserved from the profession. Their construction had been in the hands of comparatively few engineers in England but the time was coming when works of that kind would be greatly extended. The hurried manner in which street tramways were generally constructed was a matter deserving serious consideration; and it was a wonder the roads stood as long as they did. An effort should be made to obtain from the Board of Trade some relaxation of the rule limiting the amount of roadway to be opened at one time to 100 yards. Local authorities were very severe in enforcing those restrictions upon tramway companies. Companies were often blind to their own interest in urging engineers to push forward their works so rapidly. To assist in rapid work the Author recommended the use of bituminous concrete. He had tried it, but it had not answered his expectations. The Glasgow tramways were laid almost exclusively upon bituminous concrete, and the paving had sunk there to a greater extent than he had observed anywhere else—certainly more than it did upon cement concrete, if time were given it to set. If any material could be found which would set more quickly than cement concrete, a great advantage would be made in the construction or tramways. He agreed with the Auther in his approval of cross sleepers. He had recently laid a road with tie-rods. It was a macadamized road with hard rock pitching underneath; cross sleepers would have involved excavating the hard rock pitching, and then the foundation of the road would have been seriously weakened. Under those circumstances he was induced to use tie-rods; but though the expense was considerably reduced, he regretted that he had not taken out the old pitching, and laid a substantial bed of concrete. The box rail was certainly a good one; but having regard to the probability of increased weight on tramways in the future, and to the introduction of steam locomotives, he was inclined to think that the T-shaped rail was the best. He did not object to the use of the rail with the central groove, because he thought it the best form for tramway purposes. The waste of the guard rail, carrying no traffic, was saved, and the whole surface of the rail for the tread of the wheel was utilized. Nor did he think that the flange was weakened, or that the car was more liable to leave the rail. In his opinion a simple form of construction would be two ordinary flat bars set on edge, and secured to cast-iron chairs, resting on cross sleepers. If necessary the chairs could be cast to receive wooden cushions under the rail to deaden vibration; but he believed that by the use of the central groove the width of the rail could be diminished and many other advantages obtained. He should watch the use of it in Liverpool with great interest. He agreed in the recommendation of tar grouting, which was extensively used in the North of England. The principal objection to it was the impossibility of applying it in wet weather. Borough engineers could stop up a whole street and cover it with a roof under which to carry on grouting operations; but the ordinary tramway engineer was not so fortunate; and hence tar grouting, though most effectual was useless unless a continuance of fine weather could be insured; because the grouting must proceed as rapidly as the rest of the work, and a few days' rain would spoil the whole operation. He did not agree in the disapproval of cast-iron crossings and preference for cut rails. Cast-iron crossings were not as durable as could be desired, but no doubt in a short time steel points and crossings would be cast, though hitherto he had failed to obtain them. It was difficult to make a neat crossing by cutting iron rails, but it was much more difficult to do so with steel rails. He believed that iron tramways would supersede wooden ones. He had watched the process of laying the tramway in Manchester, and noticed that the workmen had no difficulty in pinning down the rail to the cast-iron sleeper With regard to the cost of tramways, he thought that a single line, including paving, but without any contingent expenses for engineering or company's affairs, might be set down at from £4,000 to £4,500 a mile.

*From Proceedings of the Institution of Civil Engineers, London.

It was difficult to estimate the cost of repairs, although it seemed that there had been a great increase in the cost of renewals and of repairs of late years. He hoped that the new tramways now being laid would show a better result in that respect than their predecessors.

Mr. Rapier said, several years ago Mr. Deas, M. Inst. C. E., consulted him as to the best way of obtaining some easement to the traffic along the Broomielaw, Glasgow. At the time he referred Mr. Deas to the tramways for ordinary street traffic at Ipswich, and in the Devonshire Street goods yard, which had been worked for twenty years without repairs, not subject, however, to such incessant traffic as that of Glasgow. The result was that the construction of the tramways, wherein the bottom flange was discarded. These tramways had been in constant work for seven years, and had not cost sixpence per mile for maintenance or renewal or repair of any kind. At first it seemed desirable to have a bottom flange at the outside of the blocks, but it was found inconvenient in fixing the paving setts. The bottom flange was then put on the inside; that did very well, but, economy being the order of the day, it was cut away altogether with the most satisfactory results. The blocks, which were adapted both for flanged and unflanged vehicles, were cast with recesses at the ends to receive fish-plates, which were bolted in the ordinary manner. The blocks were entirely filled with concrete composed of 1 part of Portland cement and 7 parts of gravel and sand well punned in, and allowed to lie three or four days to set. The road was made like an ordinary first class street or dock road, with the bottom in dry rubber, and a base of concrete was prepared for the tramway blocks, 1 foot 10 inches wide and 6 inches thick. The tramway blocks were then turned over and were fixed with Portland cement to the concrete bed. In a few instances, where the blocks had to be raised for laying water or gas pipes, it was found that they had stuck to the concrete beneath, and had to be actually cut away.

	First.			Second.		
	Cwt.	qrs.	lbs.	Cwt.	qrs	lbs.
Weight of cast iron block per lineal yard	3	2	14	2	3	0
	£	s.	d.	£.	s.	d.
Cost of cast-iron blocks, per lineal yard	1	5	4	0	19	0
Cost of concrete for filling and foundations, per lineal yard	0	4	8	0	3	4
Cost of laying blocks, per lineal yard	0	2	0	0	2	3
Total cost per lineal yard	1	12	0	1	4	0

Such a road was, of course, contrary to all preconceived notions. Though elasticity had been constantly avoided, this road was thoroughly rigid. The blocks once laid, remained there. At first tie-bars were used and it was found that they were not necessary, because the blocks could not be got to stir even when it was required to move them. The first part of the tramway had been laid seven years. Shortly afterward the price of iron rose so rapidly that he ceased to think about the matter; but when the subject was about to be brought before the Institution he wrote to Mr. Deas, and received the following particulars:—From one hundred to one hundred and forty railway trucks went over the busiest part of the tramway daily, which was equal to a vehicle twice the weight of a tramcar passing every five minutes. He had inquired whether any regular railway locomotive had passed over the line. The reply was that none had done so; but that contractors' locomotives constantly passed, often dragging heavy loads upon bogies to the 60 ton crane. The highest speed of the railway vehicles was about 5 miles an hour, and of the street lorries 6 miles an hour. The tramway was chiefly designed for street or dock lorry traffic, which in Glasgow was very heavy; and it was a noteworthy circumstance that, if horses had to turn off the tramway, they always went back again of their own accord. The tramway was made of cast-iron; he had therefore asked Mr. Deas how many blocks had been broken, and the reply was, "Not one." The blocks were ordinarily cast in 5-feet lengths. It was originally expected that in order to get them to lie steady 10-feet lengths would be required; but it had been found unnecessary to increase the lengths, because the blocks never showed any signs of motion. About six years ago 3 or 3½ furlongs of the same kind of tramway, for flanged vehicles only, had been laid in the Glasgow Corporation gas yard, and the manager reported that it had worked very well and occasioned no trouble. The edges had little notches ½ inch wide cast in them, at intervals of 3 or 4 inches, for the use of vehicles crossing the road; and he feared that there might be fractures from that cause, but none had occurred. The only thing beginning to need repair was the granite horseway between. In addition to the tramway along the street, two double lines were laid across the thoroughfare, to obtain access to a railway yard, and the whole of the ordinary traffic along the river-side passed over them, but no complaints had been made of horses falling down. The cost of the tramway had been £3,500 per mile, or £1,000 more than ordinary tramways, if made so as to accommodate unflanged, as well as flanged, wheels. For flanged wheels only, the cost was about £100 per mile more than that of other types of tramway. The latter, however, were now costing £250 a year a mile for repairs, although they were only beginning to get rickety, and no one could say what their condition would be in three or four years. He might add that the traffic on the Broomielaw tramway was incessant.

Mr. W. Martineau said his connection with a large tramway car building firm had given him opportunities for becoming acquainted with what had been done in the construction of tramways in England and abroad. In England and Scotland the ordinary 4-feet 8½-inch gauge had been almost universally used. In Ireland the Irish railway gauge of 5 feet 3 inches had been followed, but he thought it was a little too wide for the convenient working of tramways. In a few other countries a narrow gauge had been adopted. Thus the Madras tramway was on the mètre gauge, and the same gauge had been laid in Rome. In the Isle of Man and in one case in Ireland the gauge was 3 feet. He thought there was no objection to the narrow gauges; but whatever the gauge might be, it was of the utmost importance that it should be maintained throughout the whole length of the tramway. Nothing contributed more to the destruction of tramway wheels than a line being a little out of gauge; and wherever wheels were found to wear unduly, the engineer might be almost certain that some part of the line had not been truly laid. He thought that cross sleepers were advisable, and indeed necessary for the preservation of the width throughout.

The weights of the cars and wagons employed on different systems were shown in the following table:—

Weights of cars and wagons constructed by the Starbuck Car and Wagon Company, limited.

Carriages—					Cwt.	qrs.	lbs.
London car to seat 22 in and 24 out				weight	49	3	0
Hoylake	"	22	"				
24 out				"	46	3	7
Birkenhead	"	22	"				
24 out				"	47	1	14
Oporto	"	20	"				
20 out				"	40	2	0
Middlesbro'	"	16	"				
16 out				"	34	0	0
Naples open car, with 5 transverse seats to seat 20				"	21	1	20
Naples car to seat 12 inside only (with partition)				"	26	3	14
Naples car to seat 16 inside only				"	34	0	0
Brussels car	"	16	"	"	34	0	0
Middlesbro'	"	14	"	"	24	1	0
Sheffield	"	16	"	"	29	0	0
Leeds	"	18	"	"	31	0	0
Tramway goods trucks—							
Pernambuco wagon				weight	29	2	11
Oporto open goods				"	27	1	1
" covered goods				"	32	1	0

N. B.—The weights given above include wheel and axles.

It would be seen that the weights varied from 2½ tons for a full sized car carrying forty-six passengers, to as low as 24 cwt. for a light one-horse car carrying fourteen inside. Some heavier cars weighing over 3 tons (not mentioned in the table) had been made for Russia. They had wrought-iron under-framings, iron panels and elliptic springs. The Author had stated that india-rubber springs might be got to endure every climate, but it had been found that they would not bear the extreme and lasting cold of a Russian winter, for which steel springs were indispensable. The Russian engineers also prefer screw brakes. These things, of

course, rendered the car much heavier. Fortunately, St. Petersburg, where tramways were largely developed was level, otherwise great difficulty would be experienced in dragging the cars. Light one-horse cars had been introduced in England, particularly at Sheffield, Leeds, and Leicester: and abroad, in Naples, Oporto, Antwerp, and Brussels; and he thought they would be brought into extensive use. An eminent French engineer, in reporting to the Municipality of Paris about a year ago, stated that the essence of a tramway was to keep up a continuous flow of traffic, so that as far as possible, a car should always be in sight; and that could often be much more economically attained by a light one-horse car than by heavier cars with two horses. With regard to the duration of cars, the Author stated that cars had run in the United States for twenty years. It should be known that those cars had no stop seats, for there could be no doubt that the heavy weight of a top seat, with a number of people on it, did, in starting and stopping, strain the framework of a car, and that therefore cars without such seats lasted the longest. American wheels combined extraordinary hardness in the tire with great toughness in the body of the wheel. There were not many wheel-making firms in America, and the procedure of each firm was to a certain extent secret. A quality of iron was secured which admitted of crystallization and chill entering a remarkable distance into the fibre of the iron, and a careful system of annealing was adopted after the wheels were cast. The question of construction of tramways had long since been discussed. He had a plan for tramways for the whole of London, dated January 1851; also a sheet of tramway sections dated 1854, in which most of the points as to the structure of the permanent way of tramways were laid down. He had attended several trials of steam tram-cars, and it appeared to him that on a level line little difficulty was experienced. The limit of incline, which the Author had put at 1 in 30 for tramway rails laid in England, was probably reached much earlier than that. An engine was required which would start with hesitation on the the gradient, whatever it might be, in all states of the weather; and in order to secure that result, in any particular case, the amount of adhesion was an absolutely known item in the calculation. If the amount of adhesion implied a weight on the wheels greater than the rails would properly and economically carry, the limit was reached, and either heavier rails must be laid or the use of steam be abandoned. The use of steam in each case must be determined by the strength of the line to carry the weight of an engine necessary to work on the steepest incline.

(To be continued.)

AMERICAN SOCIETY OF CIVIL ENGINEERS.

BY-LAWS.

SECTION 1.—The regular meetings of the Society shall be held on the first Wednesday in each month. There shall be meetings of the Society held on the third Wednesday in each month "for professional improvement, and the encouragement of social intercourse among men of practical science," at which papers shall be read and subjects discussed relating to the theory and practice of engineering, and no other business transacted. The Board of Direction may suspend meetings of the Society in the months of July and August.

A Convention of the Society for professional discussion and social intercourse shall be held annually at such place as the Society determine, and be presided over by a Chairman selected from among Members not officers of the Society. During the Convention, regular meetings of the Society, to be presided over by the officers of the Society, may be held for the transaction of business.

The officers of the Society may give a reception at the Society's rooms, on the evenings of the second and the fourth Wednesday of each month between October and April, for the purpose of informal professional conversation and social intercourse. Regulations concerning refreshments and the invitation of guests may be made by a committee appointed for the purpose, but shall be without expense to the Society.

SEC. 2.—At the regular meeting of the Society, the following order shall be observed in the transaction of business, unless set aside for the time being, by a vote of the Members present.

1st. The record of last meeting to be read, approved and signed by the Chairman and Secretary.

2d. Candidates for membership to be balloted for.

3d. Communications received since the last regular meeting to be announced, and read if required.

4th. Communications from members present to be read.

5th. Communications from the Board of Direction to be brought forward.

6th. Reports of committees to be called for.

7th. Unfinished business to be taken up.

8th. New business to be proposed.

9th. Questions for debate to be discussed.

The same order shall be observed, as far as practicable, at the meetings of the Board of Direction.

SEC. 3.—All decisions of the Chair, on points of order, shall be conclusive, unless reversed on appeal to the meeting.

SEC. 4.—Every motion shall be first stated by the President, before debate or taking the question, and every motion shall be reduced to writing, if the President or any member desire it.

SEC. 5.—When a question is under debate, no motion shall be in order, unless for the previous question; to postpone definitely; to postpone to a day certain; to lay on the table; to commit, to amend, or to adopt.

SEC. 6.—A motion to adjourn should always be in order, and shall be decided without debate.

SEC. 7.—If required by one-fifth of the whole number of members present, the ayes and nays upon any question shall be called, and entered upon the journal.

SEC. 8.—No motion for reconsideration shall be in order, unless one of the majority shall move such reconsideration. A motion for reconsideration being put and lost, shall not be renewed, nor shall any subject or vote be a second time reconsidered without unanimous consent.

SEC. 9.—The Board of Direction may call meetings of the Society when they deem it expedient, and shall be bound to do at the written request of seven Members, stating the purpose of such meeting. Ten day's notice shall be given to members of any special meeting; the purpose thereof shall be stated in the notice, and no other business shall be taken up at that meeting.

SEC. 10.—The rooms of the Society shall be open from 9 A. M. to 4 P. M. every business day, unless otherwise determined by the Board of Direction.

SEC. 11.—Every member shall have the privilege of introducing visitors to the room while the Society is not in session, by writing their names and his own, in a book to be provided for that purpose.

SEC. 12.—A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with the name of the donors, shall be entered by the Secretary in a book provided for that purpose, to be kept at the rooms of the Society.

SEC. 13.—The books, maps, and other property of the Society shall only be removed from the rooms under such rules and regulations as shall be prescribed by the Committee on Library, and approved by the Board of Direction.

SEC. 14.—A book shall be kept by the Librarian, in which members may enter the title of any book, map or plan, which they may wish to have added to the library.

SEC. 15.—The records of the Society shall at all times be open to Members, and such books of accounts shall be kept in its rooms as the Board of Direction may designate.

SEC. 16.—When a paper is presented to the Society, the Secretary shall at once examine it, and report thereon to the Committee on Library, with reference to this standard: papers containing old matter readily found elsewhere, those specially meant to advocate personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purpose of the Society, should be rejected. The committee shall then determine whether such paper may go before the Society. They can return it to the writer for correction and emendation, and call to their aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it. Such papers as in the judgment of the Committee should go before the Society shall promptly, upon their acceptance, be printed; others shall be recorded in books provided for the purpose. When, however, the Library Committee does not feel authorized to publish a paper, they may provide an abstract thereof, which, when approved by the author, may be published instead of the original paper.

SEC. 17.—No indebtedness shall be incurred for the Society, except under such rules as prescribed by the Board of Direction.

SEC. 18.—No bill shall be paid for the Society until it has been certified by the person authorized to contract it, and audited by the Committee on Finance.

SEC. 19.—Moneys belonging to the Society, paid to any of its officers, shall, with a statement showing for what the payment was made, be promptly transmitted to the Treasurer, who shall receipt therefor.

SEC. 20.—The Treasurer shall deposit the moneys and invest the funds of the Society, in its name, by and with the advice of the Board of Direction; he shall sign all checks.

SEC. 21.—The annual report of the Treasurer shall be certified to, by at least two members of the Committee on Finance.

SEC. 22.—The Board of Direction shall determine the order of its stated and special meetings; provide for an executive committee to act in the absence of a quorum, or during the intervals between the meetings; prescribe regulations for balloting, and generally conduct the business affairs of the Society. The record for the proceedings of the Board of Direction made since the last regular meeting of the Society shall be read at each regular meeting.

SEC. 23.—Requirements for the several classes of membership, shall be as follows:

1st.—An Honorary Member shall be one of acknowledged eminence in some branch of engineering, who has had no less than thirty years' practice.

2d.—A Corresponding Member shall be one, not a resident of the United States, eminent in a special branch of engineering, or able to supply valuable information relating thereto, who will communicate with the Society at least once a year.

3d.—A Member shall be a Civil, Military, Mining or Mechanical Engineer, who has been in active practice as such for seven years (or has graduated as Civil Engineer and been in practice for five years), and has had responsible charge of work as Chief, Resident or Superintending Engineer for at least one year; not as a skillful workman merely, but as one qualified to design as well as to direct public work.

4th.—An Associate shall be the manager of a railroad, canal or other public work; a proprietor or manager of a mine or metallurgical work; an architect or a manufacturer; or one who, from his scientific acquirements or practical experience, has attained eminence in his special pursuit, qualifying him to co-operate with engineers in the advancement of professional knowledge; but shall not himself be practicing as an engineer.

5th.—A Junior shall be one who has had actual practice in some of the branches of civil, military, mining or mechanical engineering, for not less than two years; or if a graduate of a scientific or collegiate institution—for not less than one year.

[The term Junior is to be understood as not referring to the age of the person, but to his classification in the Society for the time being. He is Junior to Members in the sense that his professional experience has had a more limited scope than theirs, whilst he is eligible to become a Member, which an Associate is not].

6th.—A Fellow shall be an acceptable subscriber to the funds of the Society, who has signified to his proposers a desire to be nominated, and an intention if elected, to become a member of this class.

SEC. 24.—Nominations and proposals for admission to the Society shall be endorsed by at least two Members, who certify that they personally know the nominee or candidate and that he is worthy of acceptance. The proposal of Member, Associate or Junior shall contain a statement, over the candidate's signature, of his age, residence, the nature and term of his professional service, and that he will conform to the requirements of membership, if elected. Honorary Members, Corresponding Members and Fellows shall not be required ot present themselves as candidates; those making the nominations shall state the grounds therefor, and certify that the nominee will accept if elected.

SEC. 25.—A proposal for transfer from one class to a higher shall be made by at least two Members, who

state the age of the candidate, and the nature and term of his professional service since his admission to the Society. Such statement shall show a degree of qualification sufficient to render the proposed, eligible to election in the class to which the transfer is asked. Upon approval of the Board of Direction, the candidate shall be balloted for, as provided in the election of members; and when the transfer is made, he shall not be required to pay an additional entrance fee.

SEC. 26.—A nomination or proposal shall be presented at the next regular meeting of the Board of Direction following its receipt; when it is thereby approved, and the applicant (if for admission as Member, Associate or Junior) classed with his consent, a day shall be fixed for the ballot to be canvassed, which shall be at a regular meeting of the Society, not less than thirty days thereafter.

SEC. 27.—When such a day is fixed, the Secretary shall conspicuously post in the room of the Society the name and class of the nominee or applicant, his residence, occupation and the name of his proposers; he shall mail to each Member, whose address is known, a notice of the same, with a letter-ballot in such form as shall be prescribed by the Board of Direction, and request the recipient to vote thereby or in person in the usual manner on the day fixed, when an open canvass of the votes cast shall be made, and the result announced

SEC. 28.—The proposers of any rejected candidate may, within three months after such rejection, lay before the Board of Direction written evidence that an error was then made, and ask for a reconsideration of the proposal, which shall be granted on sufficient grounds, and if a ballot has been taken, another shall be ordered.

SEC. 29.—Persons who shall be elected members of this Society after six months of any fiscal year shall have expired, shall pay only one-half of the amount of dues for that fiscal year, otherwise required.

SEC. 30.—Special committees to report upon engineering subjects shall be authorized only by a majority of the votes cast by the Society, and in the following manner: Any resolution proposing such a committee shall be referred to the Board of Direction, which shal examine the same and report to the Society, a concis statement of the argument for and against the appointment of such committee, which statement shall be printed and issued to the Society with letter ballot; or if the Board fails to report within one month, the letter ballot shall be issued without comment; or, the Society may vote by ballot at the annual Meeting or in Annual Convention upon such resolution, within one month after it has been submitted to the Board of Direction.

SEC. 31.—The President of the Society shall have the general supervision of the business and correspondence of the Society; he shall be an honorary member of all committees, but shall have no vote on such committees.

SEC. 32.—Additions and amendments may be made to the By-Laws at any regular meeting, provided that they have been proposed in writing and seconded, at a previous regular meeting.

ELEVATED RAILROADS.

RENEWED ACTIVITY OF THE GILBERT AND NEW YORK COMPANIES.

The two organizations, known respectively as the Gilbert and the New York Elevated Railroad companies, seem at last to have commenced work in real earnest. In either case legal impediments are so far removed that rapid transit is spoken of as an end to be realized in the near future. The first-named, the Gilbert Co., have put on 500 men within a few days to lay the foundations for the iron columns, and expect to have the entire line, from Bowling Green as far up as Central Park, in operation within three or four months. When daylight fails, calcium lights are employed as a substitute. In common parlance, the company seems "terribly in earnest." With the aid of additional men to be put on immediately, it is believed that the foundations on Sixth avenue as far up as Thirty-fourth street will be finished four months hence at furthest, by which time the several iron firms who have contracted for the superstructure will at once proceed to fulfill their engagements. The firms concerned are the Edge Moor Iron Company, of Wilmington, Del.; Clark, Reeves & Co., of the Phœnixville Bridge Company, of Pennsylvania, and the Keystone Bridge Company, also of Pennsylvania. The route is divided into three sections, of which the first named company has from Forty-second street to Twenty-second on Sixth avenue, and from Amity to Canal street on South Fifth Avenue. The Keystone Company has the section from Twenty-second street to Amity on Sixth avenue, and the Phœnixville from Canal street down West Broadway.

PRESENT STATUS OF THE WORK.

The specifications of the Gilbert Road were issued two years ago. In March last the original contracts were signed, but, owing to legal impediments, the whole thing has lain dormant until now, excepting the erection of spans covering about three blocks on South Fifth avenue. Foundations have been finished on South Fifth Avenue and West Broadway to Worth street, and at present writing are being laid in Sixth avenue on one side from Thirty-fifth street to Forty-second street, and from Eighteenth street to Twenty-second street. On the opposite side of the avenue good progress has been made. As to the ironwork, we learn that the Edge Moor Company have 50 spans in readiness for delivery, and have given orders for the entire amount required to be put in hand. The Phœnixville Company, too, have some of their work ready to come over.

A KNOTTY QUESTION.

It is surmised that the next question will be as to the right of the Sixth Avenue Horse Car Company to run double-decked cars too high to pass beneath the elevated tracks. "Do they own as high up as the moon?" somebody asks, "and if so, may they not as well insist upon carrying on their cars a flagstaff, say, 80 feet high?" Perhaps they will compromise.

In regard to money, the Gilbert Company profess to have no lack. Present supplies are ample, and resources are adequate, so they intimate, to any future requirements. Below we give the specifications for the Gilbert Elevated Railway.

Specifications.

I.—GENERAL CLAUSE.

1. The specifications incorporated in the resolution of the Board of Rapid Transit Commissioners, under date of October 4, 1875, are authoritative upon the matters treated therein.

II.—ROUTE.

1. The portion of the road to be let extends from Forty-second street along the middle of Sixth avenue to Amity street; along Amity street to South Fifth avenue; along South Fifth avenue to Canal street; thence crossing Canal street to West Broadway; thence along West Broadway to Chambers street; thence crossing Chambers street into College place nearly to the intersection of College place and Murray street, a total distance of about 3¼ miles.

III.—GENERAL PLAN.

1. The general plan of the structure shall consist of two rows of columns and two or more lines of plates or lattice girders supporting a double track railway; the outside girders to be so arranged that they shall serve as balustrades or safety guards, and that the upper surface of the top chords, the platform of the cars and the station platforms shall be as nearly on the same level as practicable.

2. Plate girders shall not be used for spans greater than 40 feet.

3. The columns shall consist of four principal members, equal and uniform in section throughout their length, firmly united, well founded, and strongly connected with the superstructure in such manner as not to interfere with the expansion and contraction thereof by reason of changes in temperature.

4. The tracks shall be laid with steel rails of approved section, weighing 56 pounds to the lineal yard, and shall be placed as near to the line of supports as practicable.

5. They shall be so arranged as to allow a clear space of 16 inches, both on curves and straight lines, between passenger cars 10 feet wide and 56 feet long, and a space of at least 4 inches between such cars and the outside girder.

6. The rails shall be spiked to transverse sleepers of Southern pine or white oak, not less than 6 inches thick by 8 inches wide.

7. All parts of the structure shall be proportioned for a rolling load of 1500 pounds per lineal foot, on each track, in addition to the weight of the parts supported.

8. Where the track is supported upon the top of the main longitudinal girders, as on curves or at stations, a strong iron balustrade shall be placed upon the outside of each track, adequately secured to the structure.

9. The foundations for the columns shall be of concrete, based on granite, and shall conform otherwise to the requirements of section 31 and subsequent sections of the appended specifications of the commissioners.

10. The maximum grade will not exceed 60 feet to the mile.

11. For the purpose of determining the lengths of the various spans, bidders may distribute the block spaces into any convenient number of equal spans, not less than 35 feet, except where the columns are on the curbs, when the spans may be reduced to 25 feet. Plans of street crossings are also left discretionary, subject only to the conditions fixed by the commissioners' specifications.

IV.—SIDINGS.

1. In case where the construction of a siding involves a widening of the superstructure, the main girders and the supporting columns on that side shall be set out to inclose all the tracks, and the columns may be placed on the curbs at longitudinal intervals of not less than 25 feet.

2. Where the specified width of superstructure is such that it will accommodate a siding without lateral enlargement, the columns may also be placed at intervals of not less than 25 feet.

3. Bids are invited for a siding, in each of these cases, to be 400 feet long from heel to heel of switches.

V.—STATIONS.

1. There shall be two stations per mile, placed at the intersection of cross streets. The station buildings to be framed of iron, supported on iron columns; sided and roofed with corrugated galvanized sheets.

VI.—SIXTH AVENUE DIVISION.

1. That part of the road in Sixth avenue, extending from the centre line of Forty-second street to the centre line of Amity street, a distance of 9,901 feet, shall be carried on two rows of columns, set symmetrically to the centre line of the avenue, not less than 21 feet asunder in the clear transversely.

VII.—AMITY STREET DIVISION.

1. That part of the road in Amity street, from the centre line of Sixth avenue to the centre line of South Fifth avenue, a total length of 1,185.19 feet, shall be carried by columns on the curb lines, 29 feet asunder in the clear transversely.

2. On this reach of the road there will be one block space of 230.54 feet, one of 459.37 feet and one of 403.57 feet.

3. The street spaces of this part of the route do not correspond on the opposite sides of the street. Reference must be had to the map on file in this office for details.

4. There will be also a curve of approach from Sixth avenue, and a curve of departure at South Fifth avenue, each struck with radius of 90 feet and turning one-quarter of a circle.

VIII.—SOUTH FIFTH AVENUE DIVISION.

1. That part of the road in South Fifth avenue, from the centre line of Amity street to the north side of Canal street, a total length of 3500.30 feet, shall be carried by one row of columns at the curb and one row near the centre line of the avenue, the two rows being at such distance asunder, not less than 21 feet, as shall permit a clear width of at least 22 feet between the outside longitudinal girders.

2. On this reach of the road there will be one each of the following block spaces, namely, 476.13 feet, 468.59 feet, 235.21 feet, 454.95 feet, 398.08 feet, 490.57 feet, and 374.04 feet.

3. There will be also the following street spaces, namely: One of 70 feet, one of 60 feet one of 57.87 feet and three of 50 feet, each requiring two spans.

IX.—CANAL STREET CROSSING.

1. The crossing of Canal street, 113 feet wide shall be by two spans of 62.5 feet or three of 41 feet each, supported by columns arranged as shown more in detail on the plan filed in this office.

X.—WEST BROADWAY DIVISION.

That part of the road in West Broadway and College Place from the South side of Canal to the centre line of Murray street, a total length of about 2728.20

feet, shall be carried by two rows of columns on the curb lines, 51 feet asunder transversely in the clear.

2. The street spaces of this portion of the route do not correspond on the opposite sides of the street, and must be subdivided, by reference to the map filed in this office, upon which the sub-distances and dimensions are marked.

XI.—TURN-OUTS AND CROSSINGS.

1. Turn-out and crossing curves shall be struck with radius of not less uhan 200 feet. They shall be laid with spring rail frogs and provided with the best form of approved safety switches.

XII.—TERMINAL STATIONS.

1. At each of the terminal stations on that portion of the railway herein specified, there shall be temporary side tracks, crossings, engine houses and car houses. Immediately beyond the terminal double crossing there shall be turn-outs, one from each main track, and the railway shall thence be laid with four parallel tracks a sufficient distance to permit the erection of an engine house and a car house, and the construction of a crossing from each of the outer tracks to the adjacent main track between said houses.

EXPECTED NEW CONTRACTS.

At the office of the New York Elevated Railroad, No 7 Broadway, the awarding of contracts hangs fire though immediate action is promised. The treasurer thought it very probable they would be given out yesterday afternoon, but the vice-president did not appear to be so confident.—*Iron Age.*

CORRESPONDENCE.

CINCINNATI, *Nov. 17, 1877.*

Editor ENGINEERING NEWS:

Sir.—I was much amused at your facetious remarks about "Surveyors in some cities who affect extreme accuracy by using a thermometer and spring-balance attachment to their steel tape-lines." What would be your surprise, should you be called upon to make a survey of a disputed line in this city, to find yourself ruled out of court, because you did not make your measurements with a Standard Rod?

How surprised you would be to learn that nearly every Surveyor in town was employed to run the line of a lot, where a brick chimney or stack had been erected to darken a hall window in the dead wall of a house; and that during the progress of the resulting law suit quite a fee was offered to any surveyor who could find *just one brick* of this stack over the line, the space between the stack and the house being ¼ of an inch.

Again, what an inducement to keep your temper it would be to learn that two or perhaps three Standards of measurements were in use at the same time. The United States Standard, of which a 10 ft. standard Rod is kept in possession of the City Civil Engineer. The Gest or City Standard, longer by 1 ft. in 1000 ft. than the U. S. Standard; this standard was used by Mr. Gest the surveyor who laid out our village many years ago and who graduated a 20 ft. rod from a 2 ft. brass rule, imported from England; (it is not certified to have come over in the Mayflower). In order to complicate matters a little a surveyor with a mathematical turn of mind, declares that the standard rod in possession of the City Civil Engineer is incorrect and forthwith adjusts a rod to agree with the re-measurement of a 100 ft. distance marked on a curb line several years ago and sets up a standard rod which is a mean in length between the United States and Gest Standards, being longer by ½ ft. in 1000 than the U. S. Standard.

But hold! I must close or your Chicago Surveyor will think this a game of brag; such is not the case, however, as these are only samples of the difficulties a Surveyor labors under in this city.

MOORE ANON.

TESTS OF THE CINCINNATI SOUTHERN RAILWAY BRIDGE.

CINCINNATI, *November 7, 1877.*

Editor ENGINEERING NEWS:

Sir.—I send you the following notes of the tests of the Cincinnati Southern Railway Bridge over the Ohio river at this point, in hopes that they will be received in time for insertion in your next issue.

The Bridge consists of an approach on south or Kentucky side of one span 110 feet in length, then a draw span of 369 feet; then a channel span of 520 feet, then two spans each of 300 feet in length. The north approach consists of one span of 1,915 feet, two spans of 190 feet, one span of 118 feet, and one span of 113 feet.

Promptly at ten o'clock, although a slight rain was falling, the test was begun under the careful supervision of Chief Engineer Bouscaren with the following results: Span No. 1, south approach 110 feet, with one engine, deflection in centre of span 0.057 feet, permanent set 0.006 feet. Span No. 2. draw, south half, with four engines coupled, deflection in centre 0.052 feet, sett .004. North half of draw with four engines coupled; deflection, 0.048 feet; sett, 0.015 feet. Whole draw span loaded with seven engines coupled, deflection at centre of span .010 feet; sett, .000 feet. Deflection of centre south half .047 feet. Deflection of centre of north half, .047 feet. Span No. 3, 520 feet (channel span) with seven engines coupled and four flat cars loaded with rails; placed two in front and two in rear of train; deflection in centre 0.174; sett, 0.003. Span No. 4 of 300 feet, with six engines coupled, deflection 0.133, sett .001. Span No. 5 of 300 feet, with six engines coupled, deflection 0.241, sett .001. Span No. 6, north approach, 191.5 feet, with four engines coupled, deflection .090, sett .003. Span No. 7 of 190 feet, with four engines coupled, deflection .074, *raise* .003. Span No. 8 of 190 feet, with four engines coupled, deflection .076, sett .004. Span No. 9 of 118 feet, with two engines coupled, deflection .034, sett .003. Span No. 10 of 113 feet, with two engines coupled, deflection .040, sett .003.

The bridge commencing at south end of south approach is level to the north end of channel span, from from this point the grade descends north at 0.060 inches 100 feet for 600 feet across the two 300 feet spans, thence descends at 1.50 inches 100 feet to the north end of north approach. As a final test two engines and four flat cars loaded with rails, coupled, were stationed about 300 yards south of the south approach of the bridge, and on signal came thundering down the 60 feet grade and on to the bridge at full speed, applying the brakes suddenly at the end of the channel span, and making deflection in the centre of the channel span of only 0.10 feet, thus demonstrating that the 520 feet span, which we believe is the longest truss span ever built, is not only practicable but also answers to the test equally well in every particular with the shorter spans.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

BRIDGES.

The Arkansas river is to be bridged at Van Buren, bonds for the purpose to the amount of $350,000 having recently been sold in Chicago.

The contract for the new South End bridge over the Connecticut River at Springfield, Mass., has been awarded to the Leighton Bridge & Iron Works, of Rochester, N. Y., for $45,700.

The American Bridge Co., of Chicago, has taken a contract to build a permanent pier for the Atchison Bridge over the Missouri, in place of the one lately undermined by the river; also for a span of iron truss bridge to replace the present trestle approach to the bridge.

Clark, Reeves & Co. have just completed an iron truss bridge, two spans, of 100 and 150 feet respectively, for the New London and Northern Connecticut Railroad. Also a two-span iron bridge, 313 feet in length, for the Wabash Railroad Company, over the Wabash river, in Indiana. They are also now ready to ship an iron bridge, 100 feet in length, to Cuba for the Carribean & St. Espiritus Railway Company. It was built under the supervision of a Cuban engineer, who will oversee its placement.

The Kellogg Bridge Company of Buffalo, N. Y., were awarded the contract for the Maumee River Bridge at Toledo, O., for the Lake Shore & Michigan Southern R. R. There will be 3 spans each 175 feet long, and one draw span 187 feet in length, to be double track with two trusses and iron stringers. They also have under construction work for the Chicago & Northwestern R. R., Kansas City, Burlington & Santa Fee R. R., North Penno & Warwick Valley Railways.

RAILROADS.

Troy, Ohio, contemplate a narrow-gauge road from Urbana to Eaton via Troy and West Milton.

It is reported that the Union Pacific Company has bought 10,500 tons of steel rails in Chicago at $48 per ton.

Portsmouth, Ohio, is anxious for forty-five miles of road to give them through connections at Huntington with the Chesapeake & Ohio R. R.

It is proposed to build a railroad of 2 ft. gauge, on the pattern of the Billerica & Bedford, from Portland, Me., northwest to Bridgeton, about 40 miles.

The Union Pacific R. R. Company have recently secured control of the Utah Northern R. R., and will extend it northward, reaching Fort Hall, Idaho, this winter, if possible.

American passenger cars seem to have actually acquired a foothold in England, not only as an exceptionable accommodation in the form of sleeping and drawing room cars, in which form they have been in use on a few lines, for some time, but as the standard vehicle for ordinary traffic.

A special dispatch from Washington, C. H., to the Cincinnati *Enquirer*, says: Arrangements are now completed for building the Springfield, Jackson & Pomeroy R. R. from here to Greenfield, without any further interruption. From prospects now it will be ready for rolling stock about the 1st of February.

The result of experiments on a large scale with iron railroad ties having been very favorable, Dr. Achenbach, the German Minister of Commerce, has ordered that the railroads under control of the State shall now employ iron ties to a larger extent. The system to which the recommodation of the minister refers is the Hill long-tie system, which according to experience, possesses great advantages, especially over the cross-tie system.

At a late meeting, in Constance, of the directors of German railroads, the following information was furnished by the officers of the railway from Hanover and Cologne to Minden. The proportion of pine ties, injected with zinc, renewed after 21 years, was 21 per cent; beech ties injected with creasote, renewed after 22 years, 46 per cent; oak ties not injected, after 17 years, 49 per cent; oak ties injected with chloride of zinc, after 17 years, 20.7 per cent. The ties which were not renewed, appeared perfectly sound. Since 1870, the Emperor-Ferdinand-Northern R. R. has used only oak ties, injected with either creasote or with chlorine of zinc.—*Annales des Ponts et Chaussees.*

GAS AND WATER-WORKS.

The city of Providence, R. I., after two years trial reports favorably on the lighting of their lamps by electricity. In a certain district over nine miles in length, 220 lamps are lighted or extinguished in less than fifteen seconds. When the device is applied to the 2500 lamps of the city the net saving for gas and labor per year is estimated at $25,000. The company claim that the use of their invention in the city of Boston would give $150,000 per annum.

A water-works is contemplated to supply the village of South Hero, Vermont, with water from Lake Champlain. Henry Harding, Civil Engineer, of Bridgeport, Conn., is to make the surveys, plans and estimate. He proposes to have the water pumped up from the Lake with one of the U. S. Wind Engine Company's mills, Manufactured at Batavia, Ill., also one tank for storage constructed by them, pipes to be patent wrought iron enameled from the National Tube Works of Boston, Mass.

MISCELLANEOUS.

The census of 1876 gives the population of France as 36,955,788.

Hawkins county, Tennessee, abounds in fine marble quarries.

From $50 to $75 per month is paid to common laborers in Mississippi and Louisiana.

Work on the new Court House at Waukegan, Ill., is progressing as rapidly as the weather will permit. The foundation is already quite a distance above the surface of the ground.

Green sand marl, has been found in Houston county, near Perry, the layer of which is two feet thick, and doubtless extends through the country. This is the first reported in Georgia, and is reported equal, if not superior, to the celebrated New Jersey green sand.

A number of stone axes, perfect in form and excellently preserved, have been fond on Contrary Creek, near St. Joseph, Missouri. They are supposed to be relics of the stone age. A brick wall has been uncovered at quite a depth, the bricks being made of clay and some kind of straw.

The American Dredging Company of Philadelphia, have just completed and shipped a dipper dredge, which has an iron hull and crane, and is fitted with the latest and most improved appliances, for the Nicaraguan Government. It will be used upon the improvement of the San Juan River, and has been built under the personal supervision of A. G. Menocal, C. E., who has charge of the improvement.

About the close of the present month the funds for the building of the United States Post Office in Philadelphia will be exhausted and work will cease. There is a balance of $188,967.72 set apart for stone cutting in quarries, which will enable this portion of the work to be continued for several months longer. The amount estimated for this continuation of the work the next fiscal year is $500,000, though a larger sum could be advantageously extended.

The timber used in the Comstock mines cost $17,000 a day; the fire wood, mostly consumed by the steam engines, $6000; candles burned in the mines $10,000; the quicksilver lost $2000; and the ice needed to cool the water for drinking in the hot lower levels, $1000 a day. The consolidated Virginia alone uses ice daily worth $180. Over two tons of bullion, containing 40 per cent. in value of gold, is produced, valued at from $130,000 to 150,000.

The Kingston (Ont). *British Whig* of recent date says: "An oil tank vessel designed for the oil trade between Sarnia and Montreal, has just been completed. Some 85,000lbs, or 42 tons of iron have been consumed, and the tanks, of which there are six, three on each side, will carry about 400 tons of oil. Two more tanks will be made to lie on the deck of the schooner. The capacity of the six tanks will be nearly 114,000 gallons, and the total when fully loaded, about 150,000 gallons.

The Society formed in France a year or two ago for the purpose of surveying for a canal to unite the Atlantic and Pacific by the Darien route, is making progress in its operations. Its explorers are busily at work in the United States of Columbia, under the direction of Lieutenant Wyse, who reports his confidence that an inter-oceanic canal by way of Columbia will soon be an accomplished fact. He especially favors the Columbian route, because it will not require such expensive locks as the Nicaragua route while the lowest gradients and the narrowest isthmuses are found in Columbia.

The buildings of the coming Paris Exposition in 1878, are the largest yet conceived for the purpose. The nave of the main building is nearly 2,200 feet long; the vista, which includes the two vestibules, is more than 2,360 feet; and each of the transepts and vestibules more than 1,100 feet. The eight industrial courts are all parallel, and are divided into two series of four each; one series being devoted to the productions of France, and the other to the rest of the exhibiting nations. In the centre of the garden between the two series are two ranges of fine art galleries. On the opposite side of the river is the Trocadro Palace, which is to be devoted to the history of man from the savage state down to the most modern appliances of science and art. It will afterward be used as a municipal museum.

It is asserted that the St. Clair Flats ship-canal is a failure. The Port Huron *Commercial* says that the long, expensive cribs, filled in with earth and planted with willow trees in the hope that their roots would hold the soil against the action of the water, fail to answer the expectations of the engineer who planned the work. Great gaps appear all along both sides of the canal, and after each storm the signs of disintegration are alarming. There is a constant heavy expenditure of money to stop these chasms. This year forty tons of marsh hay, 20,000 bundles of barrel-stave splinters, thousands of bundles of brush, and a great many fascines have been put into the holes, and as fast as an old one is filled a new one appears. Singularly enough, the old channel, dredged out twenty years ago, and left with nothing above water to mark the course but buoys, is as deep as ever, and shows no signs of filling up.

The following is a brief synopsis of the report on the Chicago Custom House from the annual report of the supervising architect to the Secretary of the Treasury: "Since the date of my last report statements were made to the department of the plans modified from the originals, and in accordance with which the way the building was being constructed did not fully carry out the recommendations of the committee appointed to examine the building. After a careful examination by your predecessors, directions were given for the preparation of plans contemplating the greater equalization of weights in the upper portion of the structure, by utilizing the stonework already up. In accordance with these directions the modified plans were prepared, and under these work on the building has steadily progressed during the season. The stone and brick walls of the building will be completed during the present month. Contracts have been entered into for the iron work of the roof. The work is in progress. Contracts are also made for slating and copper work. The total appropriation is $4,700,000; amount expended, $4,500,715.29; balance in the treasury, $199,284.71."

The Téméraire, eight, 8,412 tons, 7,000 horse power, Captain M. Culme-Seymour, ironclad double turret ship, having been fitted with the electric light, a number of experimental trials were lately carried out on board in the repairing basin, Chatham dockyard, with the object of enabling the authorities to be satisfied as to the official working of the light previously to the vessel taking her departure from this port for the Mediterranean, which she will do in the course of a few days. The electric lights on board the Téméraire, as is also the case in the Alexandria, are fitted in a commanding position of the ship; and during the trials, which were carried out under the supervision of the Admiral-Superintendent of the yard, C. Fellowes, C. B., and other officials, every portion of the vessel was vividly lighted up while for a distance of several hundred yards around the ship the minutest objects on the surface of the water and the land were clearly discernible. Indeed, so powerful was the light that during the experiments the houses and buildings in Chatham and Rochester, including Rochester Cathedral and Rochester Castle, a couple of miles distant, were brought out into full relief, and were clearly discernible as the rays of the powerful electric light were directed towards them. The crucial trials, which lasted some time—the night being exceeding favorable for the experiments—were considered to be exceedingly satisfactory, and it was the unanimous opinion of all who witnessed them that the Téméraire possesses in the electric light a most powerful auxilliary in enabling the presence of torpedoes and other obstructions, as well as the position of any vessels, hostile or otherwise, to be readily and clearly ascertained, although some miles distant. The electric light apparatus on board the Téméraire and the Alexandra having proved such a valuable acquisition to those vessels, the Admiralty has now directed the contractors to put similar apparatus on board the armor plated turret ship Dreadnought, which is now fitting for sea at Portsmouth.—*Scientific American.*

A dispatch to the St. Louis *Times* of Nov. 12, says:—"Mr. H. Casey Young, of the 10th Tenn, District, will tomorrow introduce in the House a bill comprehending the reclamation of the waste and overflowed lands of the Mississippi Valley. The bill provides for the issue of bonds, guaranteed by the United States, to the amount of $45,000,000, and creates a levee district embracing the States adjacent to the Mississippi river, from Missouri to the mouth. A levee board is created of five members, composed of three army officers and two civilians, the salaries of the latter to be $3 000 a year each. The board is required to make a survey of the river and report to Congress a plan for the reclamation of all overflowed lands and those now protected by levees, and the means of such reclamation by levees, cut-offs and outlets. The whole cost is not to exceed the amount of the authorized bonds—$45,000,000. The States in which the lands lie are to impose a direct tax on the lands to be benefited, the tax to be collected by the United States government and devoted to the payment of the interest on the bonds, and the creation of a sinking fund for their final payment. The bill also provides for a tonnage tax on the commerce of the river to assist the payment of the expense of the work.

The Virginia, (Navada,) *Crusade* says:—"The estimate of the monthly sum each company benefited by the Sutro Tunnel would have to pay under the terms proposed by Sutro unnecessarily alarmed a few timorous individuals. There is not the remotest possibility of the terms referred to being acceded to. The cost of the tunnel has been greatly overstated by Sutro, as can be very easily demonstrated. On the first of January, 1875, the total progress made in the tunnel was 8,079 feet. In the ensuing 32 months, up to September 1, 1877, the progress made was 9,811 feet, making the total length of the tunnel to that date 17,880 feet. The expenses of the company during the thirty-two months referred to were less than $25,000 per month. Admitting that they averaged $25,000, the total actual cost of the 9,811 feet run during those thirty-two months was $300,000 or a fraction less than $31.55 per foot. This includes the cost of all the material used, machinery purchased, etc. Accepting the cost per foot of the work during these months as a fair average of the cost of the whole work, the total cost of the tunnel when completed to the Comstock, a distance of 20,170 feet from its entrance, should not exceed $1,644,863.50 for preliminary surveys, first cost of machinery, most of which was purchased in Europe at low figures, and some of which was paid for in stock, buildings, teams, etc., we have a grand total of $2,000,000 which is a very liberal allowance. What has become of the balance of the $3,000,000 which it is claimed the tunnel has cost? This is a conundrum which the Tunnel Company must answer satisfactorily before the total annual cost of the tunnel can be determined with sufficient certainty to base upon it the monthly amount to be paid the Tunnel Company if the terms proposed by Mr. Sutro are not acceded to."

Ironclads should be handled about as carefully as glass when the mercury is many degrees below zero. The Russian government is bemoaning the folly of the Grand Duke Constantine in not realizing the effect that would probably result from the vibrations of cannon firing on board of a monitor when the iron composing the hull and machinery was under the influence of severe frost. Last winter, when the Baltic was frozen over, and solid ice kept the Russian fleet still and motionless within the harbor at Cronstadt the Grand Duke, fearing the crew of the ironclad "Peter the Great" would be unprepared for any emergency which might occur in the spring, issued orders for the officers and men to pass through a series of gun drill. Three out of the four 35-ton guns belonging to the monitor had been dispatched to the Black Sea for the defense of Odessa, so that the practice could only be carried on with one. The result of the firing has been made apparent in the discovery of the porosity of the hull the cracking of cylinders and the fracturing of other portions of the machinery. A committee of naval experts examined the boat and experienced no difficulty in arriving at the cause of its terribly damaged state. There was an Arctic temperature of 40 and even 50 deg. below zero at Cronstadt very frequently last winter.—*Iron Age.*

At the monthly meeting of the Quebec Harbor Commission, held recently, the following report was presented and read for the month of October, and adopted: —The appointment of the Honorable Mr. Chauveau's successor as Harbor Commissioner has not yet been made by the Federal Government, but there are reasons to believe that it will shortly take place. The Resident Engineer, Mr. Pinkington, reports that the contractors have been steadily at work during the month, and that great progress has consequently been made in the harbor improvements now under contract. The whole of the cribwork blocks at the ballast wharf end of the works have been sunk in position and are now being completed to the level of nine feet six inches above low water, this latter position being bound together throughout the entire length of 582 feet, so as to form one continuous block. The filling and leveling up of the timber work of the Gas wharf crib-work has been completed from end to end, and the whole length of 798 feet is now completed in this respect. The Dredger has removed 9,000 cubic yards of dredge material from the line of the Commissioners' wharf, 7,200 yards of which has been dumped at the Gas wharf end of the works, behind and in the cribwork, and 1,800 yards have been similarly deposited at the Ballast wharf. The work of clearing the flats at low water is proceeding.

CONTRACTORS.

The Phœnix Iron Co. has finished the construction and is now putting up in place, ten iron bridges on the line of the Quebec, Montreal, Ottawa & Occidental Railway, of Canada. The dimensions of each of the bridges are as follows: Six spans of 120 feet each and one draw 130 feet, four spans of 160 feet, one span of 129 feet, five spans of 215 feet, five spans of 50 feet, five spans of 100 feet, seven spans of 150 feet an spans of 200 feet. The work was commenced in February and has been progressing ever since.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society. Associate of the Institution of Civil Engineers.

ADDENDA.

Continued from page 326.

TABLE NO. III.

Particulars of iron bridges actually constructed by Messrs. Clarke Reeves & Co. All these bridges have cross floor beams of iron. The longitudinal track stringers are of wood, unless otherwise mentioned. The general loads assumed for calculation are the weight of iron in column 9, plus the rolling load in column 7, and weight of track assumed at 400 lbs. per lineal foot. Iron in tension strained to 10,000 lbs. per square inch. In compression "Phœnix" columns, upper chords of 12 to 15 diameters from 8 to 10,000 lbs. per square inch; 20 to 40 diameters 4 to 6,000 lbs. per square inch. These bridges are designed with leaning end posts unless otherwise described, and are all with two trusses.

1	2	3	4	5	6	7	8	9	10
In what year built.	Where and for whom.	Deck or Through.	Number of Tracks.	Clear length of Span.	Width between centres of Trusses.	Rolling Load lbs. per lineal foot. General.	Rolling Load lbs. per lineal foot. Floor and Pnl. System.	Weight of iron in lbs. per lin. ft. of clear span	Remarks.
				ft. in.	ft.				
1875	Ottawa River, Montreal and Ottawa Railway.	D	1	50 0	10	4000	4000	594	Upright end posts.
1875	San Paulo and Rio Janeiro, Brazil.	T	1	65 6	15	3000	4500	605	
1874	Hudson River, Albany N. Y. Central	T	2	70 0	29	6000	6000	1420	Iron track stringers and sidewks.
1870	Baileyville, Boston and N. Y. Air Line	D	1	79 0	10	4000	4000	784	Upright end posts.
1872	Little Wabash, Ohio and Mississippi Railway	T	1	92 0	16	3000	3600	672	
1872	Greenbriar, Chesapeake and Ohio Railway	D	1	100 0	10	2500	3600	637	Upright end posts.
1875	New Orleans and Mobile Railway.	T	1	104 0	15	2500	4000	622	
1875	Ticonic, Maine Central.	T	1	111 0	16	2500	4000	655	
1872	Greenbriar, Chesapeake and Ohio Railway	D	1	120 0	10	2500	3500	714	Upright end posts.
1874	Lennoxville, Grank Trunk Railway	T	1	118 0	16	2500	4000	740	" " "
1874	Biddeford, Eastern of Massachusetts	T	1	130 0	16	2500	4000	726	
1873	Little Androscoggin, Grand Trunk.	D	1	135 0	11	2500	4000	770	
1875	Norwich Falls, Norwich and Worcester.	T	1	145 0	16	3000	4000	910	Iron track stringers.
1860	LaSalle, Illinois Central	D	1	154 0	12	2500	3500	862	
1875	Lewiston, Maine Central.	½D	1	161 0	16	2500	4000	954	Upright end posts.
1872	Hudson River, Albany N.Y. Central	T	2	177 0	28	6000	6000	2585	Iron track stringers
1872	Medora, Ohio and Mississippi.	T	1	160 0	16	2500	3600	810	
1874	Ticonic, Maine Central	T	1	170 0	16	2500	4000	856	
1872	Scottville, Ohio and Mississippi.	T	1	172 0	16	2500	3600	873	
1875	Thamesville, G. W. of Canada	T	2	180 0	29	4500	8000	1940	Iron track stringers.
1874	Ristigouche, Intercolonial of Canada	T	1	200 0	18	2800	3600	1140	" "
1874	Miramachi, Intercolonial of Canada	T	1	200 0	18	2800	3600	1105	" "
1874	Waterville, Maine Central.	T	1	200 0	16	2500	4000	1076	
1875	Ottawa River, Montreal & Ottawa.	T	1	200 0	16	2500	4000	1055	
1874	New River, Chesapeake and Ohio.	T	1	250 0	16	2000	3500	1285	
1875	Susquehana River, P. W. and B	T	1	251 0	16	2240	3500	1421	" "
1776	Susquehana River, P. W. & B.	T	1	307 0	16	2240	3500	1895	" "
1870	Chester Creek, P. W. & B.	T	2	150 0	26	2500	3500	1320	
1875	Ottawa River, Montreal & Ottawa.	T	1	150 0	16	2500	4000	836	

The American system of sending out a specification of requirements and leaving each contractor to work out his own design, whilst having some disadvantages, undoubtedly tends to develop the talent and skill of engineers and contractors to a greater extent than our home system of allowing the engineer to make a design and invite tenders for its construction. The working of the former system entirely depends upon the plans being examined by a competent engineer and the board of directors accepting implicitly his decision without for one moment entertaining the question of accepting the lowest tender. English practice is too apt to seduce an engineer into erring in making the bridge strong enough irrespective of weight or cost. The following specification, sent out in 1877, whilst containing much information, clearly indicates the manner of procedure across the Atlantic:

GENERAL SPECIFICATIONS

For Railway and Highway Bridge combined, to be erected for the Chicago, Milwaukee & St. Paul Railway Company, over the Wisconsin River at Kilbourn City, Wisconsin.

The entire superstructure will be of iron, including floor-beams and track stringers. Cast iron will not be used, except for minor details. The railway company will furnish and place in the work the cross-ties, guard timbers and rails for the railway, and the planking, floor-joist and hand-rail for the highway, and furnish to the party erecting the structure, timber and lumber necessary for the false work. Commencing near the east bank of the river and extending westerly, in the order named, the following spans will be required: One span of 53 ft., measured from the centre of its east end pin to the centre of the east end pin of the next span. This will be a deck bridge for the purpose of carrying the railway track over the approach of the highway. One span of 247 ft. from centre to centre of end pins. One span, the centre of the west end pin of which is 98 ft. west of the centre of the west end pin of the 247 ft. span before mentioned. The 247 ft. span will carry the railway track on deck, and on iron floor beams suspended from the pins of the lower chord will rest the floor-joists and planking for the highway, and said joists and planking for highway will be continued on the same level and supported for a distance of 63 ft. under the 98 ft. span by iron floor-beams suspended from the lower pins of said span, or from an independent truss. No sidewalk will be required, but the clear width between posts of the trusses of the 247 ft. span, and also the suspension rods of the 98 ft. span, if so constructed, must be at least 14½ ft. between any upper member and the top of suspended floor-beams for highway. The floor-beams for highway may be placed at such distance below railway track as will permit the beam to pass either under or over and close to the lower chord of the long span of the present structure, plan of which is herewith annexed. The clear width between the trusses of the 53 ft. span shall be the same as that between the trusses of the 247 ft. span. The gauge of the railway is 4 ft. 8½ in.

Quality of Iron.—The iron subject to tensile strain shall be tough, ductile and of uniform quality, capable of sustaining not less than 50,000 lbs. per square inch of sectional area when tested in large or long lengths, to have an elastic limit of not less than 26,000 lbs. per square inch; the reduction of breaking area shall average 25 per cent., and the elongation of the bar before rupture to be at least 15 per cent., and when cold a round bar 1 ½in. diameter must bend through 180° without sign of fracture. The iron subject to compressive strain must be tough, fibrous, uniform in quality, and have an elastic limit of not less than 25,000 lbs. per square inch. Cast iron (used only in minor details) shall be of the very best quality. The pins and all parts subject to shearing or bending strains shall be of the best quality of wrought iron.

Weight of Structure and Moving Load.—In determining the total weight of the structure for the purpose of calculating strains, there shall be added to the total weight of iron in the several spans 350 lbs. per foot of bridge for weight of rails, splices, spike, cross-ties and guard timbers above and exclusive of floor-beams and stringers for upper floor, and 550 lbs. per foot of bridge for weight of planking, floor-joists and hand-rail on the portion of bridge sustaining highway from lower chord pins. The first-mentioned span of 53 ft. over approach of the highway will carry a single track railway above upper chord, and in calculating chord strains add to the dead weight 350 lbs. per foot for weight of track, etc., and use a uniform moving load of 4,000 lbs. per foot of bridge. For post and tie strains, use the above dead weight, weight of track, etc., and the same moving load headed by a weight of 72,000 lbs. on a distance of 12 ft., and not produce strains in any of its members exceeding the maximum hereinafter mentioned. The 98 ft. span will carry a railway track above upper chord, and in calculating chord strains, add to the dead weight the weight of track, etc., 350 lbs. per foot of bridge, and use a uniform moving load of 3,500 lbs. per foot, then add 8 per cent. to the strains thus derived for end panels, 6 per cent. for second panel, and use normal strains on and from the third panel from the ends on top chord and its corresponding lower panels, and for post and tie-strains use the above static weights and a uniform moving load of 3,500 lbs. per foot headed by a load of 72,000 lbs. on 12 ft., and not produce strains in any of its members exceeding the maximum hereinafter mentioned. In case any portion of the highway roadway is suspended from the lower pins of this span, its dead weight, weight of floor and a uniform moving load of 50 lbs. per square foot of roadway surface, must be considered in calculating strains. In case the 63 ft. of roadway for highway purposes under the 98 ft. span is supported by an independent truss, it shall be proportioned to sustain, besides its weight 550 lbs. per foot of floor, a uniform moving load of 50 lbs. per square foot of roadway surface, in accordance with the requirements hereinafter mentioned. The 247 ft. span will be proportioned as follows: For chord strains use a uniform moving load of 3,100 lbs. per foot, in addition to the dead weight of structure and floors, then add 8 per cent. to the strains thus derived for end panels, 6 per cent. for second and third panels, and use normal strains on and from the fourth panel from the ends on top chord and its corresponding lower panels. For determining strains in posts and ties, add 700 lbs. per foot to the static or dead weight and weight of floors, and for rolling load use 2,400 lbs. per foot, headed by a weight of 72,000 lbs. on 12 ft.

Tensile Strains.—The iron work to be so proportioned in each span that the maximum strains produced by the dead weight and floors, together with loads specified, shall in no instance cause a greater strain in tension than 10,000 lbs. per square inch upon the bottom chord and main ties, except the middle main ties, which, as well as all counter ties and suspension rods, shall not be strained to exceed 8,000 lbs. per square inch. Floor-beam suspenders and all other members liable to receive sudden shocks in tension, shall not be strained to exceed 4,000 lbs. per square inch.

Crippling Strains.—The ultimate crippling strength in lbs. per square inch of section of the several forms of posts, struts and chords, will be determined by the following formulæ, in which formulæ H equals the length between the end bearings in terms of the least diameter:

	Square col.	Phœnix col.	American col.	Common col.
Flat ends	$\frac{38,500}{1+\frac{H^2}{8850}}$	$\frac{42,500}{1+\frac{H^2}{4500}}$	$\frac{36,500}{1+\frac{H^2}{3750}}$	$\frac{36,500}{1+\frac{H^2}{3700}}$
One pin end	$\frac{38,500}{1+\frac{H^2}{5000}}$	$\frac{40,000}{1+\frac{H^2}{2250}}$	$\frac{36,500}{1+\frac{H^2}{2250}}$	$\frac{36,500}{1+\frac{H^2}{1500}}$
Two pin ends	$\frac{37,800}{1+\frac{H^2}{1900}}$	$\frac{36,600}{1+\frac{H^2}{1500}}$	$\frac{36,500}{1+\frac{H^2}{1750}}$	$\frac{36,500}{1+\frac{H^2}{1200}}$

The pin being so placed that the moment of inertia is, as near as practicable, equal on both sides of same. Use formulæ for common column. The maximum strain permitted in any compressive member will be the quotient resulting from dividing the common strength, as determined by the above formulæ, by a coefficient of safety, equal to $4+\frac{6H}{100}$. "H," as before, being the measure of length in terms of least diameter.

(To be continued.)

The Permanent Exhibition Company is in debt to the amount of $84,000, and among the several efforts making to discharge this indebtedness is one inaugurated by the Exhibition Association for a grand fete to be held in the Main Building on on Thanksgiving Day.

"FIRST ANNUAL REPORT OF THE DEPARTMENT OF PUBLIC WORKS,"—CHICAGO.

It will be seen by the title that a change has taken place in the official designation of this report, the last being the "Fifteenth Annual Report of the Board of Public Works," etc. The Board of Public Works and the office of Commissioners of Public Works, vested in these members, Messrs. Prindiville, Thompson and Wahl, were abolished by city ordinance on the 18th of September, 1876, and all the powers, duty and authority of said Board vested in the Mayor of the city. This change produced considerable comment at the time, and developed a most pertinacious "stick-to-it-iveness on the part of the commissioners, which, however, was overcome without any particular difficulty.

The Report is for the fiscal year ending Dec. 31, 1876, and includes about nine months of the old Board. It seems rather antiquated for a '76 Report, but we notice that it contains the report of the test of the West Side Pumping Engines, is dated April 25, 1877, and the Mayor's Report, May 1, 1877.

During the year the completion of the West Side Pumping Works has added 30,000,000 gallons to the daily supply, making the combined capacity of all the engines 100,000,000 gallons. The aggregate consumption for 1876 was 15,346,922,158 gallons,—over 42,000,000 per day, or 103.3 per day per inhabitant on an estimate of population of 407,000, which seems much too low. The greatest daily average was for the month of August—44,408,693 gallons. The West Side engines did not commence pumping until Nov. 6.

There are now laid over 416 miles of pipe, of which 6⅓ miles, mostly large sizes, were laid during the year. Of these pipe 70⅓ per cent. are six inches in diameter, or less against 70⅓ per cent. average of thirteen principal American cities. 329 miles of these pipes have been laid since 1861.

There are 2901 fire hydrants; 57,130 taps, or one to 7.1 inhabitants; 38 four-inch service connections, and 9 six-inch; 1,446 meters, of which 133 were added during the year, and 84 water engines, of which 36 were added in the past year.

The total income of the water works from the time when distribution commenced, Feb. 15, 1854, to present time, has been $7,558,576.50, of which $333,963.78 was collected in 1876; of this there was collected from meters and engines $159,049.50. The net income from the works, after paying expenses and interest on bonds to the amount of $391,475.80, is $160,787 72. The cost of adding to the works during the year was $257,662.19, and the entire cost of the works from their beginning to the present is $3,179,158.59.

The following table is given in regard to the receipts for each million gallons in the principal cities. The showing is favorable to Chicago:

Milwaukee	$ 48.46	per million	gallons.
Chicago	50.30	"	"
Detroit	50.58	"	"
Hartford	63.90	"	"
Cincinnati	74.82	"	"
Brooklyn	86.28	"	"
Montreal	100.74	"	"
Boston	121.99	"	"
Cambridge	172.91	"	"
Lowell	250.44	"	"

The expense due to pumping at the North Side was $138,914.72, or 9 564 per million gallons, of which $7.15 is due to the coal account. The entire expense at both stations was $146,063 39 or at the rate of $9.517 per million gallons.

Under the head of "Sewers" we note 266 miles of completed sewers of which only 2.8 miles, however, were completed during the past year. The Mayor makes timely suggestions on the subject of sewer ventilation which, we may say, has scarcely yet awakened attention in Chicago, and which, on account of Chicago's peculiar site, is nearly of as much importance as the sewers themselves. We make free to say that in the matter of sewer ventilation Chicago is justly open to adverse criticism.

There are 127 miles of streets "improved" (!) by cindering, gravelling, macadamizing, and by stone and wooden blocks, of which 11 miles were "improved" the past year. About 100 miles of wooden-block pavements have been put down. A large amount of this has been done by private contract with property owners, "the city not interfering or dictating as to the kind or form of pavement to be used." The Mayor says: "The wisdom of the policy which fails to adopt a uniform system of paving, is somewhat questionable. From past experience and observation we are forced to the conclusion that the city should have control of the streets, dictating and deciding as to the kind of improvement to be used, as well as fixing the time for doing such work, when required by public necessity." He suggests the beneficial effect of such a law; states that "owing to various causes, such as the use of improper material, the rapid decay of the same and the increasing travel and traffic" many of our streets are in a condition requiring repaving, and others extensive repairs. We should say they did. The Mayor's remarks are very timely, but altogether too meek. He says further that "the city has suffered no material loss or inconvenience by the temporary postponement of this work." Perhaps not. On the era of the next Report let the Mayor drive at a lively pace down Washington street, in front of the Board of Trade building for instance, apparently in mid-air nine-tenths of the time and only resuming his seat sufficiently long to get a fresh start upward, and by the time he has a lively sense of the acrobatic feats he is performing, break his wagon axle,—then go back and write his street report, and we prophesy it shall be redundant in good old Saxon metaphor and hyperbole. The direct damage is great. It is a nuisance. The whole street management is an abomination. An inch or two of nasty filth, vile smells, boots and clothes impregnated with a disgusting menstrum, ruined tempers, etc. Let all who have anything whatever to do with our streets, repent of their ways before it is too late, for great shall be the wrath to come.

To resume, the average life of pine blocks is put at six years (as laid in this city they become a nuisance in two), and cedar blocks on good foundations are recommended as being found best by experience and lasting one-third longer than pine. There are 673 miles of sidewalk in the city.

The Fullerton Avenue conduit, built for the purpose of renovating the North Branch is estimated to cost, complete, $571,631.07. The Mayor thinks it will be ready for use by the summer of 1878, but we do not think it will be completed and in operation until a year from that time.

The City Engineer's Report is more than usually interesting. In addition to the regular report of the year, there is embraced a history and description, with illustrations of all the important public improvements made under the City Engineer's direction. As we expect to publish a large portion of this matter we will confine ourselves to a synopsis.

The report of the water works embraces ninety pages. It gives an account of the operations of the year for the North Side works accompanied by tables of statistics, a description of the general condition of the works, building and grounds, with illustrations, leading dimensions, etc., of the four pumping engines on the North Side, along with a plan of the works and a perspective view. A plan and perspective views of the new West Side works is given along with the description, illustration and leading dimensions of the new pumping engines. There is also added the "Report of the Commission for Testing the West Side Pumping Engines," the Commission for the first test consisting of Moses Lane, Charles H. Haswell, Henry Warrington, Charles Hermany and Thomas Whitman; and for the second and final test of Moses Lane, Charles H. Haswell and Henry Warrington. This report is accompanied by diagrams.

A history and description of the old Lake Tunnel, of the new Lake Tunnel and Land Extension, and of the Lake Tunnel Crib, accompanied by four plates, is given.

Sewerage embraces a history and description of the Chicago system, which, on account of the peculiarity of the site, is well worthy of study.

The Fullerton Avenue Conduit is described at length and illustrated.

The two tunnels under the river, the Washington street, and the La Salle street, are also described and illustrated, and a long history of the Outside Harbor is given. A sketch map of the city is added.

The report on Streets, Bridges and Buildings, with the exception of two illustrations of the Blue Island Avenue Viaduct is as uninteresting as usual. The whole document of 253 pages is terminated by the Financial Statement.

Altogether this report is the most interesting of Chicago's more than usually interesting reports.

If any of our readers desire it we would inform them that ENGINEERING NEWS does not have it for distribution. If you send to the Department of Public Works be sure to include postage, probably fifteen cents.

Chicago has no "City Engineer." The official designation is merely a *nom de plume*, a pleasing fiction, misleading to a portion of the public who would place upon him the responsibility for jobbing pavements, viaduct monstrosities and foundations for public buildings. With these he has nothing to do and is not even consulted officially. He is at most the Engineer of Water Works and Sewerage, and has something to say regarding the Outer Harbor. He also designed the Washington street, and the La Salle street Tunnels. All these works testify to his eminent ability.

Commissioners of Public Works may serve a wise purpose in many cities, but in Chicago, although on the whole they have an honorable record, they had quite outlived their usefulness. It was a very general and apparently well founded belief that they had degenerated into a machine for letting profitable contracts, making rebates and allowing extras, and when the Mayor declared war against them and commenced actual hostilities terminating in their utter rout, the public were heartily glad. The Mayor has assumed to himself the duties of the Commissioners, and we may hope that the old system of "tunnel operations" on the part of contractors has largely ceased. We had wished to see the Mayor take a definite stand and not remain satisfied until the reforms were pushed to their legitimate conclusion. His report indicates that he appreciates the situation but his vertebral column does not appear to be stiffened to the work.

We should like to see this done:—First, the city to assume absolute jurisdiction over the streets, and the designing of city pavements to be done by the City Engineer, and their construction in all details to be carried out under his direction.

Wooden pavements have been adopted in some of the streets of London and are there looked upon favorably, their life being two to three times longer than here Properly designed, honestly constructed wooden pavements will last twice as long as the present wooden pavement in Chicago. Second, the City Engineer to have charge of the designing and erection of all bridges, viaducts, etc. The designing and construction of this class of work requires a high degree of scientific ability which is best found in the City Engineer's office.

Third. The building department to be placed under the charge of the City Engineer. Architects may be employed to make the arrangement of parts, design facades, furnish the ornamentation etc., but the engineer should at least look carefully over the plans to see that the foundations are properly designed for their location, and that the walls, columns, floor-beams and roof-trusses are of sufficient strength and of an economical type. The numerous failures of public structures in various parts of the country during the past year would, we think, make such a provision exceedingly wise.

This thought is strengthened at the present time by the fact that the City Hall foundations, which are now under construction, are quite different from those of the Court House, the former being simply concrete of three feet thickness, and the latter of pile-work and concrete. We do not intend to venture an opinion as to which is the better, or say that either is inadequate, but as the two buildings are to be connected, forming essentially one structure, we seriously question the wisdom of placing the two parts on different foundations. When we interrogate the Superintendent of Public Buildings he states that as regards the form of foundation, their general character and the weight per square foot insistent on the clay, he has acted entirely under orders and refuses to be responsible. He farther refuses to give any opinion as to their adequacy or merits, or the wisdom of adopting a construction different from that of the Court House. In fact he is a very genial, courteous, close corporation. The orders under which he acts we find are given by the Building Committee of the Common Council.

Now the present Building Committee may be per-

fectly competent, but it cannot always happen that the intuitive genius of the committees of a Common Council will be sufficient to decide, by simple ballot, abstruse engineering questions.

What we dislike is the well developed system of utter irresponsibility existing in our cities. Who is responsible in a building committee. Who is responsible in a department of public works, divided into numerous bureaus with separate heads, having co-ordinate and often overlapping jurisdictions. There are a dozen to claim the merits of every successful work, and not one on whom can be fixed the responsibility for failure.

Chicago has many things which truly need reforming but the condition of her engineers in their freedom from political intrigue, and the wise suggestions of Common Councils, and the trust which her citizens repose in them, is Paradise compared to either Detroit, Cleveland or Pittsburgh.

The public works of Chicago are by no means complete. The present water system is adequate for a few years only, when additional works will be necessary, and at some not very distant day, a new tunnel. It may be expedient to draw the water from a point farther out in the lake, thus necessitating a tunnel extension and a new crib. Such a construction has been advocated on account of sewage contamination, the argument being the pollution of the water for a few days last spring on account of the efflux of a large amount of sewage from the river and branches, the accumulations of a winter carried out a long distance on the spring freshet. With the completion of the Fullerton avenue conduit, this nuisance would be removed as regards the North Branch, and the closing of the Ogden-Wentworth ditch will greatly aid the South Branch. The time will soon come, if it is not already here, when it will be inexpedient to turn the sewage into the lake, the current setting through the South Branch and long level of the Illinois and Michigan Canal transporting it to the Illinois river. This increase of sewage will make the South Branch as great a nuisance as ever, but when that time comes, the canal will undoubtedly have attained the dignity of a ship-canal, carrying a large volume of purifying water through the heart of Chicago. Ultimately this will end in a system of intercepting sewers, with pumping stations on the southwest limits of the city.

The sewerage system of Chicago is yet in its infancy, but we think all the parts have been well planned and with an idea to such future development. It is hardly necessary to add that with the completion of works under way or contemplated, sewage contamination can hardly be expected to extend out to the crib. The extension of tunnels farther into the lake is a contingency quite too remote for present consideration.

We have written thus at length, because in various quarters, from very suspicious motives, covert attacks have been made from time to time against our City Engineer and his works. Mr. E. S. Chesbrough has held his present official position for twenty-two years, undisturbed by, and apparently unconscious of, factious City Councils, holding uniformly public confidence and esteem for his sterling integrity and ability. The least that can be said is that he has won a reputation among the eminent engineers of this country, as engineer of Chicago and as Consulting Engineer in many of the largest city works elsewhere.

Criticism is always allowable, and we should be the last to vote for its abridgement. The greatest are liable to mistakes of judgment. But when such criticism proceeds from incompetent sources and is instigated by parties whose interests would be best served in the displacement or resignation of our City Engineer, (we think we speak advisedly), it is our province to "speak out in meeting" lest a public uninformed in engineering matters should be deceived. This is particularly so when one of our greatest morning dailies, the one that assumes to represent all the morality and culture of this city, prints in full these allegations and gives the two replies of one of the ablest and best known engineers of this country, only after they are cut, slashed and garbled beyond recognition, so as to be without point or apparent purpose. These incidents are now some months past, but are liable at any time to be repeated as part, apparently, of a well-defined plan. We allude to them here on account of this favorable opportunity.

THE IMPROVEMENT OF THE TENNESSEE RIVER.

There will assemble at Chattanooga on the 5th proximo a convention composed of the governors, boards of trade and public spirited citizens of three states, to urge upon Congress the importance of a more vigorous prosecution of the work of constructing a ship canal around Muscle Shoals of the Tennessee river. The importance of this movement is not to be underrated The Tennessee river is sixth in magnitude in this country, and runs through five States. It is a river of great size and beauty, averaging five hundred yards in width from its mouth to Knoxville, 720 miles; its average volume for the year is nearly that of the Ohio; it is much more constant in flow, and is never obstructed by ice in winter when the navigation is best, thus making it a constant competitor of the railways in cheap transportation, which cannot be said of northern rivers, closed for several months by ice, and is an additional argument for its improvement. Besides all this the localities needing improvement are in rock, which, combined with the character of its flow, render all structures permanent. Considering the amount of navigation benefited and the interests involved, the expense to be incurred is comparatively nominal. A few facts will render our meaning clear.

The Tennessee, from its mouth to Waterloo, Ala., 415 miles, is navigable the year round for the largest class of boats drawing four and five feet. From Waterloo to Brown's Ferry, 47½ miles, are several shoals over which it is impossible to go, except for a few days, at very highest water. These shoals consist of Colbert shoals, 6 miles in length 12 miles of good water, Little Muscle Shoals 4½ miles long, 2 miles of good water Big Muscle Shoals extending 17 miles to Bainbridge, 5 miles of good water, and Elk River Shoals extending 11 miles to Brown's Ferry.

The United States Government has already let the contract for the greater portion of the work around Big Muscle Shoals, the worst obstruction in the river, but with the usual driblet appropriations it will take several years to complete the works. Above the shoals 285 miles to Knoxville, good three feet navigation exists for nine months in the year, and two feet the year round. The government has already expended $150,000 on this portion of the river in building wing-dams, etc., and an additional $50,000 will give three feet the year round. For six months in the year there are 625 miles of tributary navigation on the upper Tennessee and its branches which at no great expense can be increased to 985 miles throughout the year by a judicious slackwater system. Thus we find 1245 miles of natural navigation to be benefited by the improvements now contemplated or in progress, the greater portion of which is closed by the obstruction at Muscle Shoals. With the slackwater system mentioned this would be increased to over 1600 miles. We believe the government contemplates five feet low water navigation to Guntersville, Ala., the proposed terminus of the Atlantic & Great Western Canal, as recommended by Senator Windom's committee on Transportation Routes to the Seaboard in 1874.

The country which will find in the Tennessee its natural commercial highway includes some 150,000 square miles, comprising North Alabama, part of Middle Tennessee, all of East Tennessee, and a portion of Georgia, Virginia and North Carolina. The climate of this valley is admirable, suffering neither this enervating heat of the Southern state, or the piercing cold of the North. Wheat matures six weeks earlier than in our northwestern states. The mountain sides are covered with the best of timber. The mineral resources, are, however, the most important. East Tennessee has 3700 square miles of coal area, and Northern Alabama 4300 square miles, of which at least 3,300 square miles are tributary to this river. The coal is bituminous except in the northern portion of the valley where it approaches the character of cannel coal. Its general character is excellent and experience demonstrates its adaptation to iron manufacture. In close proximity to the coal deposits brown and red hematite iron ores are found in unlimited quantities. At many points are found spectacular and magnetic ores, manganese, limestone, fireclay, marble, slate and other valuable minerals.

The practical results of opening up this region, nearly in our midst and almost a *terra incognita*, scarcely need discussion. Suffice it to say that we know of no region where the government can accomplish so much with so little money.

The radical improvement of the upper Ohio which we earnestly advocate, would undoubtedly produce many times the results, but at an enormous though amply justifiable expense, extending through many years. This can be done quickly and cheaply. There is such a thing as unwise economy. It is exhibited when government improvements drag along several years on account of insufficient appropriations, costing much more than the original estimates. The Des Moines ship canal is an illustration.

As denoting the perfection of American locomotive building, we notice that on Nov. 16, at the Detroit shops of the Michigan Central Railway, two locomotives were completely set up in the space of three hours. Steam was raised and the locomotives made a trip of seventy-six miles as a test, running satisfactorily.

We take pleasure in noting that Mr. Edward M. Grant, C. E., a graduate of the Rensselær Polytechnic Institute of Troy, N. Y., of the class of 1860, is chief of the corps of correspondents of the London *Times* with the Russian army in Europe, and is winning many laurels in that capacity. So says the *Engineering and Mining Journal*: The London *Times'* war news and field maps certainly cannot be excelled.

The merchants of Philadelphia, in conjunction with the Reading Iron Company, are taking active steps toward the establishment of a steamship line to Brazil and adjoining South American countries. As the greater part of our trade relations with those countries is transacted through Liverpool, it would seem as if direct steamship connection should be had at an early day, if we would control the trade which should belong to us

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The bill to provide representation at the Paris "International Industrial Exposition," as it passed the House, provides for one Commissioner-General at a salary of $5,000, and twenty additional commissioners at $1,000 each, not including such clerical services as may be necessary. Of these twenty commissioners, five shall be practical artisan experts, five shall be skilled representatives of commerce and manufactures, nine shall be scientific experts, specifically appointed to report on the nine groups into which the Exposition shall be divided under the official regulations, and one to report upon the Exhibition at large.

The President may also appoint one hundred additional honorary commissioners, to report upon special subjects, who shall serve without pay. It is generally understood that the Governors of States are to have the appointment of two of the honorary commissioners each, the remaining twenty-four being reserved for Presidential appointees.

A Government vessel is to be provided to transport American exhibits and again return them to this country, free of charge. Let all engineers sincerely hope that by some accident a competent civil engineer may find a place on the commission.

A meeting was recently held in New Orleans to take action in regard to the construction of the New Orleans Pacific, to extend from New Orleans to Dallas, Texas, a distance of 336 miles. Dallas has already subscribed $60,000 contingent on favorable action in New Orleans, and proposes to build the road from the State line to that city. The road has been under construction for some time in both directions from Alexandria, and there now remains to be graded in Louisiana only 85 miles, which, it is estimated, can be done for $14,000 per mile. Mr. J. E. Clarke, Vice-President of the Jackson Railway, in an address, thought the necessary half million could be raised. No definite action was taken farther than to obtain subscriptions in the audience to the amount of $15,000. There are now 640 men at work on this road; but construction must soon cease unless additional funds can be raised. New Orleans has only two railway outlets, the Jackson and Mobile roads. All her projected railways west and northwest have hitherto been bought up and killed by Morgan, the steamship man of the Gulf, in order to protect his shipping interests. New Orleans should have a trunk line west to Galveston and one northwest to connect with Texas

Pacific. Through these she should control the trade of the fertile and fast developing eastern and north-eastern Texas, and become also the most important sea-port terminus of Texas Pacific, which, in any event, will be constructed at no distant day.

The metropolis of the South, her greatest commercial centre, a city of 200,000 inhabitants, she should do all this and more, and it does not speak well for her picayune enterprise that one ship-owner should throttle these projects. Of course the great arterial system of the continent has hitherto brought its life blood to her development, which is well, and the opening of the mouth of the Mississippi speaks volumes for her future. But with these and other advantages, greater than those hitherto enjoyed by any American city, her lying still, and hazily dreaming that she is to be the future great metropolis of America will not make her so. Now that she is free from that stunting thraldom, for which relief she has so long and loudly prayed, let her be up and doing, or the world will think she has already passed her dotage, and that her future prosperity will be in spite of herself.

LETTER FROM ROBERT FULTON TO JAMES MADISON.

The following interesting extract from a letter of Robert Fulton's to James Madison from "The Magazine of American History" is of interest :

November 5, 1814.

To James Madison, Esq.

Dear Sir: On Saturday morning, 29th inst., the steam frigate was safely launched, amid the acclamations of many thousand anxious and now well pleased spectators. She draws eight feet two inches of water which is six inches less than I had calculated. She moves easy, and appears to have removed from every mind all doubt of her success. She is prepared for and will carry thirty-two long 32-pounders, served with red hot shot. I have the pleasure to inform you that thus far she corresponds to my calculations and meets my entire wishes. Her speed from the steam engine will, I think, be at least four miles an hour. If so, all nautical men agree that her advantages over the enemy's vessels will be numerous and important. I do not hesitate to say that, from calm reflection, the impression on my mind is that this invention, practiced to its utmost powers, must produce a total revolution in maritime war and the political relations of the United States with Europe. But this opinion will be proved correct or erroneous in six or eight weeks, when her machinery shall be finished. When we prove steam vessels of war to be superior to vessels with sails France, Holland, Denmark, Sweden, Prussia, and Turkey, who are minor maritime powers, will use them in their narrow seas against England and each other, while in the British Channel, the Baltic, and the Mediterranean such attacks on the present vessels will be their annihilation, yet steamships cannot act on the Atlantic. Consequently that and every other extensive ocean must be free, for they are now deprived of freedom by vessels, all of which are constructed and come from narrow seas, where steam vessels can act to advantage.

Fulton was undoubtedly greatly in advance of the thought of his time but he could see no further into the future than we. The wonderful improvement in steamship commerce, indeed, no one could prognosticate. There are many who would say that all the great inventions have been made, and indeed it is hard to imagine any future invention fraught with so much to civilization as the application of steam and electricity. The latter has recently received some astonishing, and in many respects most wonderful applications in the telephone, and the instrument yet without a name for permanently recording the sounds of the human voice. The man who writes about the limits to the application of natural forces to the use of man, is fossilized. Let us wait and see, and when we grow old the young world will have so run away from us with wonders that we cannot understand, and that confuse our lagging brains, that we shall be ready to die.

The United States Grand Jury, November 28th, found indictments against Thomas Walsh, Superintendent, and William K. Patrick, late Assistant Superintendent, of the new Custom-House and Post-Office building in St. Louis. The indictment charges Messrs. Walsh and Patrick with conspiracy to defraud the Government by issuing false certificates as to the cost and quality of building material for the Custom House, and as to the pay-rolls. The amount indeed is large, the transactions extending over several years. The parties involved are old and respectable citizens.

(Written for ENGINEERING NEWS.)

STREET PAVEMENTS.

A street pavement should be smooth, noiseless, cleanly, and free from dust; it should be readily adjustable and removable for the purpose of reaching sewers and pipes beneath the surface; it should be as cheap as possible consistently, and with these requirements, and it should be durable. Experience has demonstrated that but two substances are suitable—stone and wood, unless we include concrete, which, when perfect, is an artificial stone; when imperfect, is entirely unadvisable. Stone, aside from macadam, has been used in three general forms; first, the round cobblestone; second, the square stone of trap or granite; third, the block dressed to a dimension known as Russ, Belgian, Guidet, and by other names.

Although the material stone is not subject to decay, nevertheless under heavy and continuous travel it cannot be made durable against use; certainly not at any cost which American cities would be willing to assume.

The Roman causeways are often referred to, but they were made of great blocks, utterly unsuitable for travel, and simply illustrate the lasting power of stone as against decay; and this is not disputed, whether in the pavement of a Roman road or the pyramids of an Egyptian desert.

The question of durability as against use is soon answered by reference to the frequency with which they are relaid.

Experience has shown that five years is a long life for a stone pavement in New York on any street much traveled, and ten years on any street with ordinary light travel.

Of the concrete pavements, with the exception of a small amount of Val De Travers asphalt, little is known from actual experience in this country as no suitable material for the construction of this pavement is found here.

The question of durability in a wood pavement cannot be determined as quickly, however, because so many systems of wood pavement have sprung into existence and faded away almost as rapidly; and an examination into their merits will amply repay for the trouble. From experience of the English Engineers the following facts have been elicited:

*Considering wood pavements from 1839, asphalt from 1869 (Val De Travers), and stone pavements for a much longer time; wood and asphalt pavements are in several respects superior to granite, much less mud and dust is formed on them and they are comparatively free from noise, they are also safer, except when thoroughly wet.

Granite is not in any respect superior to either of them, even if they should be more costly, owing to their requiring repairs more frequently, and having to be renewed sooner; the advantages already mentioned will more than compensate for the extra price, besides many indirect benefits are secured by their use, which it is not easy to estimate in money; and there are many expenses connected with all pavements which are not always included under the head of maintenance,—on the whole it seems that either wood or asphalt (Val De Travers) is destined to supersede granite as a paving material, at least in large and wealthy towns.

The following table of prices from the same able paper will be found convenient for reference:

1st.—Macadam and Macadam concrete.

Average price from 1861 to 1873 per cubic yard	4*s.* 10 *d.*
Average price in Edinburgh per ton	6*s.* 6 *d.*
Average price in granite 5oz. metal per ton	16*s.*
Cost of maintenance of Macadam per square yard	1½*d.* to 3*s.* 3*d.*

Wear on Westminister Bridge per annum 5½ inches, ordinary wear on streets and roads 1 to 2 inches.

Note. Where maintenance of Macadam reaches 10*d.* per annum paving is cheaper.

2nd.—Stone Pavement.

Granite or shives per square yard	18*s.*
Wear per annum of Aberdeen Granite ⅛ of an inch.	
Cost of repairing per annum, per square yard	3*d.*
Cost of pavement and repairs per annum, per square yard	2*s.* 10*d.*

*A paper read before the Edinburgh and Leith Society by B. H. Cunningham, C. E.

Lasts for seven years.

3d. Improved wood pavement. *London Contracts.*

Company to maintain one year free and 15 years at 1*s.* 3*d.* to 1*s.* 6*d.* per square yard per annum. First cost 16*s.* 10*d.* per square yard.

Cost of pavement and repairs per annum, per square yard, 1*s.* 2*d.* to 2*s.* 6½*d.*

Terms offered by Company, maintenance one year free and 15 years at 9*d.* to 1*s.* 6*d* per square yard per annum. First cost 15*s.* to 16*s.* 3*d* per square yard.

Cost of pavement and repairs per square yard per annum 1*s.* 7¾*d.* to 2*s.* 5*d.*

4th. *Val De Travers compressed asphalt. London Contracts.*

Company to maintain 2 years free and 15 years at 9*d.* to 1*s.* 6*d.* per square yard per annum. First cost 16*s.* to 18*s* per square yard.

Cost of pavement and repairs per square yard per annum 1*s.* 7¾*d.* to 2*s.* 4½*d.*

Mr. Cunningham then quotes from Mr. Heywood's report to the commissioner of sewers of the city of London in 1873, as to the relative safety of the several pavements as follows: "But allowing for all modifying influences wood is safer than asphalt, as not only fewer accidents occur on it, but those which do happen are of the kind least injurious to horses, and obstructive to traffic. It is the most quiet, but also the dearest; but however, can be kept equally clean and will be found equally durable; they can be laid and repaired with about equal facility, but the best repairs can be made on asphalt."

The wood pavement here referred to (and also in the list of prices given above) consists of "fir blocks 3½ inches wide, 10 inches long and 5 inches deep, set on a double flooring of fir planks laid crosswise;" of course such a pavement would be difficult to repair, it is in fact a Nicholson pavement with a double floor, tar and all.

Mr. Cunningham here gives it as his opinion, that, "except as regards safety there is not much difference between them. Wood is however about twice as safe as asphalt.

He then discusses the value of the element of elasticity as developed in the wood and asphalt pavements, (the utter absence of which in the stone pavements and Macadam is one of their greatest faults in the opinion of the English engineers,) and concludes "I venture to think that improved wood pavements will ultimately be found superior to the Val De Travers asphalt, and that the introduction of the former has been a decided step in the right direction. I also think that we may look for improvements in modifications of this system, and that a roadway having the requisite surface qualities, combined with elasticity of form, will always be superior to one whose chief recommendation is mere solidity."

It must be regarded as somewhat strange that there are those in this country who advocate the use of Val De Travers asphalt at this great distance from the quarries, while the ablest and most experienced engineers of London, Glasgow and Edinburgh, who are so near the quarries, and where wood is much more costly than with us, and at the same time their wood is so inferior to ours, are urging the use of wood pavements.

Let us now inquire as to the amount of wear in wood pavements. It has become an axiom among plank road men, that if a plank road is not *worn out* before it *rots*, the stock is a bad investment, because there is not sufficient business to support these roads; and these roads are made of 3 inch stuff, laid with the grain horizontal, with no attempt at tightness, soaking and drying alternately in the mud of a country road, and are known to last as against *decay* on an average, six years. Wood with its grain horizontal will decay *twice* as fast, and wear away *three* times as fast as with the grain perpendicular.

From experiments on the wear of wood set at various angles, and of a pavement of granite setts, by D. T. Hope, C. E., F. R. S. S. A. of Liverpool, the following deductions are made:

It appears that the amount of wear is greatest in the first month, and gradually decreases every subsequent month. For instance the wear of the first and second months is greater than any three months from the sixth, this, I think, can be very easily accounted for. Although the depth of the blocks diminished more in proportion for the first and second months, yet they did not seem

Amount of wear sustained in decimals of an inch.	Three vertical.	Fibre at 75 deg.	Fibre at 60 deg.	Fibre at 45 deg.	Fibre at 30 deg.	Fibre at 15 deg.	Fibre Horizontal	Granite Setts.
At the end of one month	.017	.023	.032	.046	.065	.088	.109	.014
Two months	.030	.038	.051	.069	.093	.120	.154	.025
Three months	.040	.051	.065	.088	.114	.143	.159	.037
Six months	.062	.078	.101	.136	.178	.231	.294	.073
Nine months	.078	.095	.120	.167	.220	.275	.363	.112
Twelve months	.096	.115	.142	.194	.253	.312	.390	.141
Fifteen months	.111	.132	.164	.219	.232	.347	.433	.193
Eighteen months	.125	.147	.182	.241	.312	.379	.490	.213
Proportions of an inch for the eighteen months	1/8	Barely 3/16	Barely 1/16	Barely 1/4	5/16	Full 3/8	Barely 1/2	3/16

to have lost much by abrasion. They had undergone compression, and presented a more compact surface than when laid down. And besides being more compact in fibre, the surface was so impregnated with fine sand that it had more appearance of stone and wood.

The vertical fibre blocks, during the eighteen months were only diminished in depth, between compression and abrasion, .125, or 1/8 of an inch. The blocks at the end of that time were in good condition as if they had not been exposed to heavy weights and abrasion.

In the blocks with the fibres horizontal, for the first month the wear was equal to fifteen months of the vertical, and in eighteen months they lost about half an inch. The fibres were separated to a considerable depth, and the surface had the appearance of a heap of broken strings. It seems indeed strange that such incompressible and durable substances as basalt and granite should be more subject to wear, with the same amount of traffic, than wood with the fibre presented to the pressure and percussion.

The former, however, when acted on by wheels and horses' shoes, resist the pressure and percussion, and thereby have their particles abraded into very minute sand; and the iron is also subject to a diminution in proportion to the hardness of the stone.

On the other hand wood, from its elasticity, yields to the pressure and permits the weight to pass over it without any sensible injury to either the wood or iron.

A reference to the table will show that wood lost 1/8 of an inch, but more from *compression* than *abrasion*; while the granite setts lost 7-32 of an inch from abrasion alone—which proves that the elasticity of wood is that which renders it *durable* and applicable for paving; and that the *non-elastic property of stone is the cause of its inferior durability.*

As to the methods of preserving wood from decay many plans have been invented, of which we will note the following: the efforts tending to neutralize the external influences of water, air, and heat, by—

First: A more or less complete removal of the water and extraction of the aqueous solutions of vegetable matters contained in and between the cells and fibres of the wood. This is done mostly by pneumatic process, in iron airtight cylinders.

Second: A subsequent injection of fluids under hydrostatic pressure, by means of which permanent chemical reactions are formed. These antiseptic fluids are either diluted *metallic solutions* (impregnation proper) or those *oily substances* obtained from the distillation of tars. The oils which are obtained at certain temperatures of distillation (varying from 180° to 230°) are charged with substances(also the product of the distillation) which coagulate all albuminous matter, rendering it insoluble, and in some degree fixed. This action penetrates even the cells where this albuminous matter is mostly found. Besides the chemical action of this kind of treatment, it also acts mechanically by repelling water, or at least reducing absorption measurably; and in the Robbins process, if thoroughly carried out, the pores become more or less closed with resinous matters.

The following processes have been used, viz:

1. First class, or impregnation with metallic solutions. (a) Burnettizing, or impregnation of chloride of zinc. (b) Samuels' process of impregnation with sulphate of iron.

2. Second class, or injection of oily substances. (a) The Seeley process, or impregnation with creosote, carbolic acid derived from *pine tar.* (b) the Robbins process, or impregnation with heavy oils charged with creosote, carbolic acid, etc., derived from *coal tar*, at a higher temperature than the Seeley process.

Of these processes the Samuels(b, First-class) has been abandoned for the reason that sulphate of iron has no affinity for the formation of insoluble combinations with the vegetable matters to be neutralized, and it has no poisonous action on low organisms when applied in diluted solutions. The disengagement of sulphuric acid (in consequence of oxide of iron being fixed upon the fibers,) also tends to exercise a destructive influence on the texture of the wood. Of the second class, while both the Seeley and the Robbins processes are still in use, it is necessary to handle the wood with great care, as the creosote produces eruptions and sores, and in Belgium its use for preserving wood was abandoned on this account. In pavements treated by these processes, as well as the Burnettizing process, in most cases thus far ascertained, the wood of the pavement is destroyed by *dry rot* from underneath; an apparently solid crust is left on top, while underneath the wood has been reduced to tinder; the dust driven into the pores of the wood by driving over it, and its compression, mostly exclude the *absorption of water and air* on the surface and thus materially contribute to its preservation, while the moisture of the ground finds its way by capillary attraction of the sand and gravel bed in the wood. It would seem in this connection as if the compound pavements which exclude the absorption of the moisture of the soil by means of a layer of asphalt, would offer more chances for *duration* than any of the systems *in which the wood has been treated*; however, the treatment of the wood and the addition of the asphalt *largely increases the cost* of the pavement. In the pavements not treated, but merely subjected to the pneumatic process of drying, it has been found, that in a damp soil or after a heavy rain, the wood swells, and the blocks being interlocked in close contact they burst, forming numerous spheroidal hunches which had to be cut out.

These several failures led to the inquiry, is it necessary to use any preservative process to neutralize the external influences of water, air and heat? I think not, for the reason that it has been sufficiently established by men of maritime experience, and shipbuilders, that those parts of a vessel which are constantly exposed to the water are never found to be the least affected, while other parts of the same vessel are undergoing rapid decay; and that decay is even arrested when it reaches the same seasoned parts. *Wood blocks in a pavement may thus be said to be quite exempt from the probability of decay*, even though they shall be perfectly dry when laid down. They are placed on a *humid*, or what will soon become humid, substratum, closely packed to each other, and *totally excluded from atmospheric influence*, saving the surface. In wet weather they absorb as much moisture as they can contain, which renders them more adhesive and compact; and from which moisture they are never after totally free, even in the dryest weather—for wood being a *bad conductor of caloric*, any variation of the *atmosphere* has little affect on the blocks, or the surface exposed to it. In proof of this a number of blocks averaging 5lbs in weight when laid down, after having been in use till properly moistened, were taken up and reweighed, when it is found that they had gained by moisture an average of 4¾ ounces. After a long continuance of dry weather they were again taken up and weighed, they were found to be still moist having lost only 1¾ ounces. This was in a pavement of *untreated* wood and *without tar.* In the Nicholson pavement, however, owing to the fact that the spaces between the blocks were filled about half their depth by strips of wood, and the other half with coarse gravel or pebbles, over or upon which *tar was poured*, the wood in both blocks and strips generally being green or wet, shrunk away from each other, and besides, the ends of the blocks were laid against each other without any filling between, and when shrinkage took place, allowed surface water to pass down freely, not only between the gravel and the blocks, and the strips and blocks, but also at the ends of the blocks. The blocks were laid on board bottoms and in most cases these sprung and warped and displaced the blocks, allowing sand and gravel to be washed down between the blocks and the boards, and the blocks toppled and rocked on these uneven surfaces. And as in general, as there was only a small amount of fine sand beneath the boards, the water remained there in all cases where the subsoil was retentive; but as these blocks were coated with tar *no dampness was communicated to them from the subsoil*, and they rotted very rapidly.

In the wood pavements laid without tar, without strips of wood to separate the blocks, without board foundations, or other costly and useless appendages the wood lasts as against decay remarkably well. A pavement which when laid with tar lasted only from three to four years, lasting about five to six years when laid without it.

The idea of using tar to preserve the wood, which was advanced as something *new* about twenty years ago in this country, originated in Russia, where, by the by, wood pavements are supposed to have originated about *three centuries* ago; and in which country the same pavement is still being laid with no alterations of consequence, and to this day they give the pavement a coating of tar annually to *counteract the effects of frost.*

The fundamental error made by American engineers is in using pavements indiscriminately, that is, stone or bowlder pavements are laid in situations and under conditions to which they are unsuited, and in like manner, wood pavement is often laid in localities for which it is not adapted, and as a result both prove failures. Stone, and more especially bowlders, should not be laid in localities where traffic is heavy, constant and rapid, and where the noise and dust are especially objectionable. Bowlders are not well adapted to street railroad tracks for the reason, mainly, that it is almost impossible to keep the boulders in place along the rails. They should not be laid where the subsoil is wet and spongy, since in such localities the gravel yields and allows the surface to become uneven and the pavement to break up.

Wood, on the other hand, should not be laid in localities where the traffic is light and infrequent, and where the wear and tear is slight. In such cases the bowlder may be laid so as to remain in position for years, and since they do not decay, the pavement will remain good for an indefinite time, while the wood in such a case probably will not be worn an eighth of an inch, but still in six or seven years will be quite decayed if of pine, oak or similar short-lived woods, and must for that reason be removed and new pavement put down. For the same reason wood pavements should not as a rule be laid on suburban streets or roads, since generally the traffic on such roads or streets is so small as to produce only a slight amount of wear, while the quietude facilitates decay; absolute quiet or rest being the most favorable condition for rapid decay of vegetable matter while constant agitation is one of its greatest preventatives.

It is the general opinion that the failure of the bowlder pavement is on account of bad material or workmanship, or both. While this may be, and is doubtless true in some cases, it is not true in all.

The real difficulty is inherent in the *form* of the bowlder, the general or prevailing form being that of two cones of approximately circular frustrums placed base to base, the length as a rule being about twice the distance. It is evident that such bowlders placed upon a bed of sand or gravel side by side will of necessity have, even at their points of contact, spaces of considerable size; and these spaces will increase both upwards and downwards to the points. Very little bond or connection between the parts can be had and besides every blow struck upon the top of the bowlder tends to drive it down into the gravel, while the cone or wedge shape of the bowlder causes it to break the matrix or seat in which it rests; this tendency is greatly increased when, as in the case generally in practice, the blow or force is oblique, since this causes the bowlder to *roll* in its bed. Owing to the peculiar form above described, the bowlder, in practice has only about two thirds of its mass

imbedded in the gravel; the upper third projecting up, leaves empty spaces about the points, when clean, and these spaces being filled with dust and other impurities of the surface when the street is dirty and dry, and with mud when wet. In locations where the street is flat and the grade approximately level water stands in these spaces during rains and when sprinkled, until it evaporates or is absorbed by the sand below. This keeps the bed damp and often wet enough to soften somewhat the bed, and from all these causes it happens that the bowlders are driven down into the bed, and the finer parts of the bed, the sand and loam among the gravel, is forced up through the spaces between the bowlders, and some of the bowlders getting below their fellows, thus loosening the side support they had originally, are displaced by the blows of the wheels or hoofs, and so the pavement once broken becomes a ruin rapidly.

When we remember that the impact of a blow is the weight of the striking mass multiplied by the velocity, we find the explanation of the rapid destruction of the bowlder pavements on our great thoroughfares, and also the reason why all attempts to secure permanence in such pavements (and indeed in about all others) by laying them in cement or similar compounds, have proved futile.

The above remarks explain why bowlders are unsuitable for paving rail tracks. The projecting points are caught by the wheels when slewing or twisting around out of the tracks, the opposite side of the tire acting against the rail and making a lever of the wheel, which acts to produce the rolling motion of the bowlder described above, and throws it out of place. This difficulty is greatly increased by the bowlders immediately along the rails being driven down, thus forming a rut in which the wheels of vehicles track, and the prying action is alike injurious to the pavement and the wheel.

The peculiar form of the bowlder precludes the possibility of obtaining a continuous line of contact with the rail, which continuous contact in very advantageous to the pavement, the rail and the vehicle.

All of the wood pavements except some of the wedge formed blocks differ from the bowlder in this, that the base of the block has the same area as any other portion of the section, and therefore will afford a much firmer pavement on a given foundation, than the bowlder. There is much less space or area of bed or foundation uncovered by the block than the bowlder, and this is the reason of their greater stability on a given bed. The vertical sides of the blocks are practically parallel and the blocks are usually six or seven inches in length. This affords ample support against horizontal movement. For these reasons there is no difficulty in securing a practically uniform surface for wood pavements, and permanence in the position of the blocks.

The same remarks apply in a greater or less degree to all the stone pavements (except the bowlder), and therefore the objections to other stone pavements as to form do not exist. They are all liable to every other objection urged against the bowlder and some in addition. They are expensive, noisy, slippery, hard upon animals, vehicles and people; though if the stone be hard enough and well put down they are durable.

In estimating the value of a pavement three things *must* be considered: First, the primary or first cost. Second, the cost of maintainance or repairs; and third, the facility of repairs when the pavement is broken up from any cause.

In putting down bowlder pavement flagging gutters are necessary to a good job, and these cost about twice as much per square yard as the bowlder pavement, but are not necessary in a wood pavement. Aside from this the foundation and other things may be regarded as the same. The bowlder pavement now in this city (Cincinnati) cost from 95 cents to $1.15 per square yard; the stone block pavement, $2.35 to $2.60; square pine block, $1.55 to $1.70; rough round block, oak or white cedar, 65c. to 75c.; rough round block, Locust, 80c. to 95c. per square yard.

As to the life of wood pavements, the Nicholson, which had such a firm hold on the public twelve or fourteen years ago, but under which patent I think no pavement is now being laid, would last about three years. The square block, three to four years; the square oak block, five to seven years; the rough round block, in oak or white cedar, from eight to ten years, and the rough round block in locust, from ten to twelve years.

The oak block pavement will be exempt from repairs for four or five years if well put down and of good material. The locust block will be exempt from repairs for nine or ten years, and at the end of this time may be repaired at small cost by simply adding a very small amount of gravel, and turning the blocks upside down. This is practicable because the bed of a rough block pavement improves with age by becoming more solid by use; there being no loss or waste from it by passing up between the blocks as in the bowlders. It does not require to be disturbed at all, while in all cases in repairing bowlder pavement the bed must be broken up and a large amount of new gravel added, while the *screenings* or old material found beneath the bowlders must be carted away.

Taking all these facts and figures into consideration, therefore, it is a simple matter to arrive at the conclusion that wood pavements of every kind are greatly superior to stone or bowlder pavements of any kind in smoothness, elasticity, noiselessness, cleanliness, easy traction, and economy of animals and vehicles; also that wood pavement is cheaper than stone or bowlder pavement estimated for a considerable number of years, even when the time involves the necessary repairs and renewal after being worn out, and if to these considerations be added those advantages which all admit inheres in the wood pavement, and which I enumerate above upon which no accurate or even approximate money value can be placed; though it is admitted on all hands they are very great, I think it is high time to have all our great thoroughfares paved with wood.

STREET TRAMWAYS.*

BY ROBINSON SOUTTAR.

Continued from page 330.

Mr. E. A. Cowper was surprised that an opinion should have been expressed in favor of iron rails over steel rails for tramways. Not only were steel rails stiffer and stronger, but they were harder. A great deal of grinding or wearing of the rails was caused by the grit and sand on the road; and a soft rail would necessarily suffer from that action more than a hard one. Any one who had observed the grinding action of emery would have noticed that it made a much deeper cut into soft iron than into steel. Steel, therefore, was undoubtedly the right thing for tramway rails.

Mr. E. Perrett observed that the Author had not mentioned what he considered to be the immediate cause of the rapid loosening of the spiked rail from the sleeper. It was impossible to suppose that the mere passage of a 5-ton car over a 30 or 40-lb. rail spiked down could loosen it. The cause was rather to be sought in the extremely unmechanical construction of the car. An ordinary London street car weighed when loaded about 5½ tons, was 22 feet in length, and was balanced on a 5½-feet or 6-feet wheel base in order to get round a sharp curve. Oscillation was soon set up which this wheel base was unable to control; and that had been the chief cause of the withdrawing of the spikes, and the abandonment of a rail which was otherwise cheap and good. He did not think that any rail would long remain secure without a more extended wheel base to the cars running over it. He was aware that cars with six wheels had been tried, but the additional weight was too much for the already overtaxed horses. When steam was introduced, together with suitable rolling stock, that difficulty would be overcome. In the cars with six wheels the wheel base was made flexible, the central pair of wheels having power to travel sideways across the car. He disagreed entirely with the conclusion of the Author that detached engines and cars were superior in nearly every respect to combined engines and cars. Leaving out of consideration such qualifications as absence of smoke, steam, or noise, which both kinds of machines might or might not have, the great requisite for a tram passenger car for use in and about towns was handiness. In this was included, power, to run either end first without turning or bringing the engine round, to ascend a steep gradient, to stop quickly in going down, to take sharp curves, and also, what had apparently been lost sight of, power to steer. The detached engine failed in all these important particulars; the combined engine need not fail in any one of them. In the case of some combined cars, the driver had only to walk from one end to the other on the return journey. With reference to ascending a steep gradient, it might be all very well to increase the weight of an engine from 3 tons to 5 tons to give the necessary adhesion, but that was not the proper way of overcoming the difficulty. A heavier engine than was otherwise necessary to do the work was a faulty machine. A detatched engine of 3 tons was not sufficient to draw a car of five tons up a moderate gradient. To drag cars on ordinary lines 20 or 30 lbs. to the ton was necessary, and on curves the traction amounted to 50 or 60 lbs. to the ton, so that the limit of gradient was soon reached by a detached engine and car, and to connect the moving parts of the engine to the car wheels to gain adhesion was making a combined car of the worst kind. The disadvantage alluded to by the Author, of an engine drawing a 22-feet car with 8 feet overhang round a curve, was obvious. Suitable cars could be made to be pulled by an engine, but that did away with the argument for the use of detached engines, namely the possibility of using up existing stock. As regarded steering power this was of no moment with horse cars as the horses gave the necessary list to the cars, but a locomotive must have points and attendants at the branches, whereas with the number of wheels necessary for a combined car, steering could be easily effected. The alleged advantages of a detached over a combined engine were: the power of using up old stock, the power to take two cars on an emergency, greater safety to passengers, and cheapness or facility of repairs. The first was no advantage in new tramways; and in the case of old tramways, especially where outside passengers were carried, he had been informed that the existing cars broke up so rapidly, owing to their unmechanical construction, that no company would care, even if it could afford, to replace the existing stock by steam stock any faster than the existing stock broke up. Independently of that, the existing stock was not fit for steam traction, being far too light. The power of drawing two cars was not peculiar to a detached engine; a combined engine and car was still more capable of taking an additional car. A detached engine was considered by some safer for passengers, but he did not remember any instance in which a locomotive boiler had exploded whilst running. The Author stated that when a combined engine was under repairs £800 would lie idle. That might be so for slight repairs, but it amounted only to this: the cost of a detached engine was about £600 and of an ordinary car about £200; the cost of an engine and car combined was £700; so that there was a saving on the original cost; and in the case of repairs to the engine the difference in the value laid up was only that between £600 and £700 or £100. But if a combined engine and car were properly made, for extensive repairs the engine could be easily detached and another substituted, in which case the amount lying idle would only be £200 or even less. He had constructed a car for experimental purposes, with a fixed wheel base of 4 feet, to which the power was attached, set on a frame that could be easily removed from the main frames of the car. A two-wheeled Bissel bogie at either end gave a 17-feet wheel base. It was capable, nevertheless, of running round a curve of 35-feet radius, and by a steering arrangement at each end, it could be taken on to the road or off the road or on the branches, without the slightest difficulty and was free from oscillation. There was a small boiler at each end connected together, the object being to distribute the weight, and also that the driver might stoke the boiler behind him, whichever way he was going, the two boilers being connected, he knew what was going on in both. The weight of the car when loaded was 8 tons, of which five tons were on the driving wheels and available for adhesion. He believed the car fulfilled all the conditions required in a passenger car. Where a tramway was like a light railway, the vices of a deatched engine were less apparent, and it might be made suitable for the work, but for ordinary passenger traffic he thought a combined car possessed every advantage.

Mr. C. B. King considered that the car just described would not satisfy the requirements of the public. In Paris, one line of tramways, 5 miles long, was worked entirely by an ordinary locomotive engine, with a spec-

*From Proceedings of the Institution of Civil Engineers, London.

ial arrangement to prevent the emission of steam and smoke, and it did its work well. He was informed that the cost of steam, as compared with horse traction, was at present as 5½*d.* to 7¼*d.*, but this was subject to variations as coal and fodder altered in price. The advantage of a combined car in obtaining adhesion had been mentioned. He, however, preferred a light detached engine. In order to increase the power of adhesion of such an engine many arrangements had been tried, the most effective of which was Holt's system adopted by Messrs. Merryweather. The engine was coupled to the car by an endles chain, passing round a chain pully on an axle of the engine, and likewise round another chain pulley on one or both axles of the car. These pulleys were disengaged on the axles by self-acting gear when the extra adhesion was not required; in some cases this chain was driven by an independent auxiliary cylinder which only worked when going up inclines. This cylinder had a much higher piston speed than the locomotive cylinders, so that a 5-ton engine could work an ordinary car up inclines of 1 in 12 and 1 in 14 in all weathers with ease. He had seen an engine of 3½ tons weight, on one of the North Metropoli an tramways, ascend an incline of 1 in 27, and go round a curve of 35 feet radius, with a car of 50 passengers. He was afraid that Mr. Perrett's car would not pass the regulations of the Board of Trade, one of which was that passengers were not to pass and repass the motive power. He had been informed that on the Paris line the public were at first much terrified at the prospect of an engine going along the road at a speed of fifteen miles an hour; but after an experience of six or eight months the idea of returning to the old modes of conveyance had been abandoned. It was found that ordinary vehicles never got on the line, always carefully avoiding it.

Mr. E. Perrett explained that the Board of Trade officials had seen the drawings of the car he had described, and offered no objection to the arangement.

Mr. Walter Hancock remarked that his uncle (whose pupil he had been) had worked at the subject of steam carriages continuously from 1824 to 1836, and had made eight or nine carriages designed to compete with carriages on common roads. He was obliged to allow for the enormous tractive force required, and for the vicissitudes of the roadway, so that the power of his engines was greatly in excess of that required on tramways. The engines were of three classes, One was a small engine, with 3⅜-inch cylinders, making 150 strokes per minute, for a carriage conveying four persons; another was a 9-inch cylinder engine, with 100 lbs. pressure of steam per square inch, making 100 strokes per minute, for a carriage conveying ten or twelve persons; and another was a 12-inch cylinder engine, with a length of stroke also of 12 inches, for a carriage to take twenty-four to thirty passengers. This was prior to the great improvements in steam engines, so that the consumption of fuel would now be considered enormous. In twenty weeks' continuous working of the "Automaton," the largest engine when making 100 revolutions per minute, to go 10 to 12 miles an hour, over a distance of 4,200 miles, 700 journeys, and carrying 12,700 passengers, 55 chaldrons of ordinary gas coke were used, equal to 20 lbs. per mile. The total cost was 2½*d.* per mile for carrying only half the number that an ordinary tram carriage would carry at a cost of 1*d.* per mile. The engines were made, as all old engines were, with defective valves, it being long before the improvements by Dewrence and others in 1837 and 1838, by which the consumption of steam had been much diminished. Not only was it necessary to carry more coke and more water, but the strength and weight of the carriage were increased, its weight when loaded being from 4½ to 5 tons. In consequence of these experiments a parliamentary committee was appointed, and in their report in 1831 the belief was expressed "that the substitution of inanimate for animate power, in draught on common roads, is one of the most important improvements in the means of internal communication ever introduced. Its practicability they consider to have been fully established; its general adoption will take place more or less rapidly, in propostion as the attention of scientific men shall be drawn by public encouragement to further improvements." Here were none of the timid fears and cautions to be found in the reports of the more recent committees.

Mr. E. Chadwick, C. B., thought that sanitary science might put in an appearance in connection with the subject of tramways. It had long since been apparent that every means of cheapening transit, and facilitating the distribution of the population, tended to diminish overcrowding in urban districts. If things had remained as they were, there might now have been in the metropolis and other urban districts a double and even a threefold population heaped up on the old areas; and however good the sanitation might have been, there would certainly have been increased death rates. His colleagues on the Metropolitan Sanitary Commission had before them the evil of overcrowding. Stone trams were suggested, of which various examples existed, reducing the horse traction more than one-half; but there were obstacles in the way, chiefly administrative, arising from the fact that all the radii out of London were split up into different parochial jurisdictions, there being one for nearly every mile of road. This division had added largely to the expenses of all the tramways, and one director had informed him that the dividends of his line had been almost taken away by the exactions of the separate jurisdictions. He would suggest that accounts of the expenses of different lines should not only contain the engineers cost per mile, but the cost per vestry. It would be seen by the evidence given before the recent Tramway Committee, that in that respect there was an enormous difference in favor of Paris, in consequence of the unity of management and scientific administration existing in that capital in having only one authority to work through, and that a scientific authority acting with knowledge, instead of obstructive from ignorance and prejudice. He still thought that the granite tram, as adopted in Italy, possessed a prodigious advantage; but a well laid asphalt might take its place, being only half the expense and double the wear. The asphalt tram had the advantage over the granite tram, and indeed over the iron tramway, in the absence of joints, and when properly laid there were no jolts. Being, as it were, in one piece from end to end, there was little or no resistance, so that it was more favorable to the use of lighter locomotive machinery and carriages, than granite or iron. The tenacity of the Neuchatel asphalt, as displayed in Cheapside, with its traffic of sixteen thousand vehicles daily, was marvellous. It had been laid down about seven years, and had apparently lost little weight, and was only compressed by about one-third, and might have a wear as long as that in Paris, which was seventeen years. The wear of the ordinary granite trams at the East of London, with much less traffic, was stated to be about 1 inch a year. Much of the first asphalt roadway was defective in being wavy and undulating from being badly laid. He had been led to believe that the saving of tractive force on asphalt roads was about the same as that on granite tramways, or about one-half, as against common macadam roads but he had later assurances that the saving on well laid asphalt was fully two-thirds of the tractive force required on the common roads, enabling a proportionate saving of engine power on them. The obstacles that stood in the way of the application of the principle of the tramway were chiefly the divided jurisdiction of the roads and the want of science, some additional outlay, and no interest, created by a monopoly, such as was given by the iron tramway; the asphalt tramway being like the granite tramway in Northern Italy and this country, open to all private vehicles, which was, in reality, its recommendation. He had been at pains to ascertain the comparative wear of the road by the wheel and the horse and he thought he could state it as a constant, that whilst the wear by the horse foot was as one, the wear by the wheel was as two. Hence the tram he proposed would take away two-thirds of the common road wear. But it would have great importance in saving the wear of common carriages, as well as of locomotive machinery of all sorts. Locomotive machines were at present excessively heavy as were carriages, to withstand the roughness of the roads. He did not mean to say that for roads of slight traffic, and for bye-ways, wheel tracks of cheaper construction than those he proposed might not be had. But a great object, as he conceived, for the attainment of economical transit was to get hardened wheel tracks open to all traffic.

Mr. Hopkins said it was evident that the time was not far distant when some mechanical power would be introduced on tramways. At present the only motive power at all complying with the requirements of the Boare of Trade was steam and compressed air. Steam engines, made by Messrs. Merryweather, were running in Paris at the present moment; steam engines were also running in Brussels. Mr. Hughes had also succeeded in producing an engine which had given great satisfaction; and he had likewise seen an engine by Mr. Perrett which had considerable merit, but it had not been brought before the committee of the House of Commons. Mr. Scott Moncrieff's engine, worked by compressed air, had been running successfully at Glasgow; and M. Mékarski's compressed air engine in Paris had worked admirably. They worked generally with a pressure of 4 atmospheres, and could run easily at 20 miles an hour, stopping within a short distance. In ascending gradients the action was perfect; the engine was stopped purposely, in the middle of an incline; about 1 in 20 and then ran down and ascended it again. The authorities were laboring under great disadvantages with regard to charging the cylinders, because they had only temporary engines for compressing the air.

(*To be continued.*)

CORRESPONDENCE.

ROCHESTER, *Nov. 20. 1877*

Editor ENGINEERING NEWS:

Sir: Please allow me through the columns of your valuable journal to submit the following practical problem to the Engineering Profession.

Farmer A has a valuable spring, the water of which he wishes to convey to his barn which is 3,335 feet distant with a fall of 133.68 feet. But farmer B holds an intermediate farm between the spring and the barn, which A must cross with his pipe in order to convey the water to his barn.

For the privilege of crossing B's premises with the pipe, A allows B to tap the inch pipe and put in a half inch spout, and from the spout to the barn the pipe is to be ¾ of an inch. But B instead of connecting his half inch spout directly with the inch pipe puts in a vertical tube 4 feet long 2½ inches in diameter, closed at each end, the inch pipe entering this tube at the bottand the ¾ inch pipe containing the flow to the barn entering at the top 4 feet above the influx. Directly opposite the efflux pipe B's half inch spout is put in 4 inches long. The pipes entering the vertical tube just pass through the material of the tube so as to be flush with the inside.

The distance from the spring to the spout is 1440 feet of inch pipe and the level of the spout is 69.96 feet below the surface of the spring.

Required the quantity of water delivered at each place, and how much more would have been delivered at the barn if B had made his connection directly with the inch pipe, with a half inch pipe four feet long instead of the stand pipe.

Respectfully yours, L. L. NICHOLS.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

PERSONAL.

MR. JOSEPH P. DAVIS, City Engineer, of Boston, sailed from New York on the 24th inst. for Europe to be absent about four months. He goes to investigate the sewerage systems.

GAS AND WATER-WORKS.

The new reservoir at North Adams, Mass., on which over $16,000 has been expended, leaks badly, and considerable more outlay will be required to render it secure.

A considerable amount of pipe, for additional service, with necessary hydrant, has recently been laid by the Taunton, Mass., water works.

H. R. Worthington, of New York, has under construction a compound condensing engine, with a pumping capacity of 3,000,000 of gallons daily, for the Boston, Mass., high service, water supply. This engine, which is to be put in at the Roxbury station, is to replace the crank engines supplied a few years since by the Boston Machine Company.

The city of Burlington, N. J., has recently contracted with H. R. Worthington, of New York, for one of

his compound condensing engines of a capacity of half a million gallons daily. It is stated that the water works system of that city, which has heretofore been somewhat inefficient, is to be thoroughly improved, and the erection of a stand pipe 100 feet high is contemplated.

Cornish & Dennis, of New Bedford, Mass., who, about two months since contracted to lay water pipes in the town of Brocton, Mass. completed the work week before last. About five miles of pipes, which were furnished by the Gloucester Iron Works, of Gloucester, N. J., have been laid and subjected to a test of 200 pounds pressure to the square inch and not a defective pipe or joint found. The engineer was Percy M. Blake, of Taunton, Mass. The works are at present supplied with water from the old reservoir of the North Bridgewater water works, but in the spring a new reservoir and stand-pipe are to be constructed.

RAILROADS.

New Zealand nowhas 707 miles of railway.

It is expected the track of the Pittsburgh, Wheeling & Kentucky R. R. will be laid to Wheeling some time next month.

The survey of the route for the extension of the Lake Erie & Louisville Road from Fremont to Sandusky, O., has been begun.

Scioto Valley R. R. Ohio, will be opened for business about the 3d of December, between Columbus end Portsmouth. Thence to Huntington, the distance is about 45 miles.

The Central Pacific R. R. Company planted 300,000 trees along the line of their road last season, and they have ordered over 700,000, which will be set out the coming season.

Enough subscriptions have been made to warrant the beginning of the work of construction on the Toledo & Ann Arbor R. R. narrow gauge. A company will be organized at once.

An ordinance has been presented in the City Council of Cumberland, Md., authorizing the issue of bonds to the amount of $65,000 to aid in extending the Pennsylvania R. R. system to that point.

Penn Yan & New York R. R. company have decided to buy the crooked Lake canal 7½ miles long for $3.333 to use it as part of the bed of their proposed road from Penn Yan to Dresden, N. Y.

The railway from Osaka to Kioto, Japan, cost the Japanese government $175,0 0 per mile. As it is an easy line to construct it begins to dawn on the Japanese that the English contractors made $100,000 per mile.

Sioux City & Pembina R. R. company have voted to extend the road from Portlandville, Iowa, the present northern terminus, to Canton, Dakota, thirty miles northwest, and early in the spring it is stated the road will be built to Sioux Falls.

Under a general law of Texas, several of the leading citizens of Galveston have chartered and organized a company under the name of "The Galveston & Camargo R. R" with a capital of $3,000,000, 5 per cent. of which is paid in.

Los Angeles *Republican* says "In the excavations made in the mountain region in building the Southern Pacific R. R., great stores of honey were found in fissures and sheltered places in the rocks, revealed in some cases by blasts in working the rock for the roadway.

The directors have been authorized to issue bonds not exceeding $100,000, sufficient to build the road from from Weston, W. Va. northerly to Clarksburg on the Baltimore & Ohio. The distance is about 25 miles, and it is said that the contract has been entered into with experienced railroad builders for the completion of the road-bed for the whole distance for the sum of $40,000. The work is to be commenced at once, and completed by the 1st of July next. It is also proposed to continue the road from Weston to Charleston, Kanawha county, on the Chesapeake & Ohio.

The Columbus & Gallipolis R. R. Company has completed two surveys to Columbus and secured the right of way on both—one by way of Ringold, St. Paul, Lockburne and Shadeville, and the other by way of Amanda, Royalton, Lithopolis and Groveport. These lines each open up a section of country which has not hitherto been directly tributary to Columbus, Ohio.

The Burlington, Cedar Rapids & Northern R. R. has during the past year added 139 miles to its line, giving now an unbroken through line from Minneapolis to St. Louis, and through its main line and branches, opening up much new country hitherto without railway facilities. The running time from Minneapolis and St. Paul to Burlington is 16 hours, and to St. Louis, 26 hours.

Articles of incorporation were signed in Columbus, O., Nov. 20, for the Columbus and Coal Valley extension of the Columbus & Northwestern R R. The line marked out is via Reynoldsburgh, Bremen and Shawnee to McConnellsville. The determination is to keep at work until the whole line is in operation from McConnellsville to Columbus, and Columbus to Fort Wayne, and from Urbana to Eaton.

The Springfield, Jackson & Pomeroy R. R. narrow-gauge, is now under active construction. The portion from Jackson to Waverly, 25 miles, is now completed and in running order, as also the portion from Springfield to South Charleston. The section from South Charleston to Bainbridge is graded and will be completed for traffic in thirty days, and active work has commenced on the section from Bainbridge to Waverly. It is expected that the road will be entirely completed by July 1st next. Money for its construction is flowing in abundance along the route.

Mr. C. H. Gamsby, C. E., of the Canada Pacific Railway survey, recently removed to Canada from British Columbia, reports two very good practicable routes through the Cascades and Rocky Mountains to the prairie country, as established by the surveying parties,—one commencing at Burrard Inlet near the U. S. Boundary, and the other at Bute Inlet, farther north, and following to a certain extent the windings of the upper Frazer. He considers that the one commencing at Burrard Inlet, on account of the strong opposing currents effecting navigation and its close proximity to the U. S. Boundary, should be ruled out, as it undoubtedly will be.

The troubles between the Pittsburgh and Lake Erie R. R. company and the Pennsylvania company in regard to the Mahoningtown crossing, have been at last definitely settled. This may be regarded as a triumph to the Pennsylvania company, for she had previously resolved to fight any grade crossing on all occasions. The basis of the agreement is as follows: The Pittsburgh, Fort Wayne & Chicago was to lower its main track at the crossing 3½ feet, thus bringing it on a level with the siding which was lately constructed. The Pittsburgh and Lake Erie is to elevate its track at the crossing 13½ feet above the present grade, thus requiring an elevated bridge over the track of the P., Ft. W. & C. This change will necessitate the building of a bridge over the highway leading from New Castle to Mt. Jackson, and other expensive additions. The Pittsburgh & Lake Erie, to cross the acqueduct to Mahoningtown, will have to raise its track eight feet above the present grade. The understanding is that the two roads will each bear one-half of the expenses of this change in the plans. No further litigation is anticipated.

CONTRACTORS.

The Baldwin Locomotive Works, Philadelphia, have received an order from the Russian government for 150 locomotives.

The Egyptian government has ordered four steamers in England for use on Lake Albert Nyanza, and for opening the navigation of Central African rivers.

The contractors for the harbor improvements, at Montreal ceased on the 26th inst. from further operations for this season, in order to get time to lay up their dipper dredge and scows, before the winter sets in.

Clarke, Reeves & Co., of Philadelphia, are now ready to ship an iron bridge one hundred and fifty feet in length, to Cuba, for the Caibarien & St. Espiritus Railway Company. It was built under the supervision of a Cuban engineer, who will oversee its placement.

Within the past four weeks the Cope & Maxwell Manufacturing Company have received orders for eighteen steam pumps from customers in California. The same concern is engaged in building water-works for Milwaukee, Wis., of 3,000,000 gallons capacity, to be completed in December.

The entire cost of the new iron bridge built by the Boston & Providence Railroad company over the Blackstone river at Central Falls, R. I., will not exceed $65,000, about equally divided between masonry and iron, while six years ago the estimated cost of the iron alone was $60,000.

The Clinton Bridge company, of Clinton, Iowa, have now under way in their shops, or in process of erection, 23 combination and 8 iron bridges, aggregating about 3,700 lineal feet. They have just contracted for 300,000 feet of bridge timber in Wisconsin, which they will need to finish up the contracts they now have on hand.

Work on the new building on the Cleveland water-works crib has been suspended for the winter. The new structure of stone is built inside the temporary wooden building that surmounts the crib, and the stonework has progressed as far as practicable without removing the old roof. The roof and tower of the new building will be of iron. Mr. McDonell, the contractor, will complete the structure in the spring. The character of the work is spoken of in the highest terms.

A Quincy, Ill., letter says: "The scheme for building a levee and railroad from Warsaw to this city is so far advanced that its success seems assured. The contract between commissioners for the land owners and the officers of the Quincy, Payson & Southeastern R. R., the latter to build the levee and railroad, has already been signed for that part of the work from Warsaw to the Hancock county line, in Adams county.

The Phœnix Iron Company has finished the construction and is now putting in place ten iron bridges on the line of the Quebec, Montreal, Ottawa & Occidental Railway of Canada, a road that is being built by the government. The dimensions of each of these bridges are as follows: Six spans of 120 feet each and one draw 130 feet: four spans of 160 feet; one span of 129 feet; five spans of 215 feet; five spans of 50 feet; five spans of 100 feet; seven spans of 150 feet, and five spans of 200 feet. The work was commenced last February and has progressed rapidly since. The iron was wrought at Phœnixville, and had to be shipped from five hundred to seven hundred miles.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society, Associate of the Institution of Civil Engineers.

ADDENDA.—SPECIFICATIONS CONTINUED.

Continued from page 334.

Pins.—The shearing strain on any pin must not exceed 7,000 lbs. per square inch of its sectional area. The strain on extreme fibres caused by bending must not exceed 15,000 lbs. per square inch, and in determining this bending strain, the leverage distance shall be considered as from centre of eyebar to centre of bearing or of opposite eyebar. No pin shall have a less diameter than two thirds of the widest eyebar coming upon it. The bearing surface of any pin on chord, tie or post shall not be exposed to a greater strain than 10,000 lbs. mean pressure on the semi-extrados. Pins must be turned true to size and straight, no error of more than 1-20th of an inch in diameter being allowed.

Eyebars.—Pinholes in eyebars shall be bored to exact sizes and distances, and to a true perpendicular to the line of strain. No error in length of bar or diameter of pinhole exceeding 1-64th of an inch will be allowed. The section of metal in the eye opposite the centre of the pinhole and perpendicular to the line of strain, shall be proportioned according to the following table, the diameter of the bar being the unit:

HYDRAULIC FORGED EYES, ON WELDLESS BARS.			HAMMERED EYES. WELDED TO BAR.		
Pin.	*Bar.*	*Eye-section*	*Pin.*	*Bar*	*Eye-section.*
1.00	1.0	1.50	0.75	1.0	1.33
1.25	1.0	1.60	1.00	1.0	1.50
1.35	1.0	1.70	1.25	1.0	1.50
1.50	1.0	1.85	1.50	1.0	1.67
1.75	1.0	2.00	1.75	1.0	1.67
2.00	1.0	2.20	2.00	1.0	1.75

No eye on a weldless bar shall have a metal section less than 1⅓ times the area of the bar, and for hammered eyes the least eye-section shall be 1⅓ the section of the bar. A drawing of the standard shape of the eye proposed to be used must be filled with each proposal.

Rivetted Work—In rivetted work all joints shall be square and truly dressed. Rivet holes shall be accurately spaced, and the rivets must be of the best quality of iron for the purpose, and completely fill the holes. In all posts and chords the the connecting rivets within two diameters of the ends shall be equal to the sectional area of the joined pieces, and in posts and elsewhere in all rivetted work the rivets shall not be spaced to exceed sixteen (16) times the thickness of the thinnest plate joined by them, and the distance between rivet supports across the plate shall not exceed thirty (30) times the thickness of the plate, and no closed section shall have members of less thickness than 5-16ths of an inch. The parts composing the posts and struts must be of entire lengths without splicing between end bearings. All workmanship must be first-class; abutting joints must be truly planed or dressed so as to secure a perfect bearing, and the pinholes in chords and posts shall be bored as truly as is specified for the eyebars. All closed work such as posts, struts, chords, etc., must have two (2) coats of approved metallic paint and boiled oil on the enclosed surface, and one coat on the exterior surface, before leaving the shop. All turned and faced parts to receive a coat of tallow mixed with whitelead before shipment.

Wind Strains shall be calculated at 30 lbs. per square foot on twice the surface of the truss, plus ten (10) square feet per foot of bridge for car-surface, and the resulting strains therefrom shall be resisted by lateral and vertical rods proportioned to 15,000 lbs. per square inch in tension, and lateral struts proportioned to a factor of safety of four (4). Shearing and bending strains at the lateral connections shall be calculated with the same precision as the main strains, and shall be resisted by members proportioned so that the maximum shearing strain shall not exceed 10,000 lbs. per square inch, and the maximum flexure or bending strain shall not exceed 22,500 lbs. per square inch.

Floor Beams and Track Stringers.—The railway floor-beams shall be proportioned for the concentration of weight occasioned by the following engine resting with middle driver over the floor-beam in question: Three drivers coupled on a side, on 12 ft. base or 6 ft. apart. Weight on drivers 72,000 lbs., or 24,000 lbs each. Two leading wheels 5 ft. apart and 6 ft. from head driver. Weight 20,000 lbs. or 10,000 each. Six feet from back driver follows tender truck; wheels 5 ft. apart and 11,000 lbs. on each.

To this live load there shall be added 25 per cent. for momentum and the dead weight of the floor and stringers, and the resulting strains therefrom shall not exceed 8,000 lbs. per square inch in compression, or 10,000 lbs. per square inch in tension. The stringers immediately under the rails shall be proportioned to carry the above described engine weight plus 30 per cent. for momentum and their proper proportion of floor. If the floor-beams and stringers are of built sections, the rivets must be so spaced that between the points of application of the load and the points of support there are rivets enough to transmit the flange strains to the web and from the web to the flange without exceeding a shearing strain of 7,800 lbs. per square inch upon the rivets, or of 10,000 lbs. per square inch of mean pressure on the semi-intrados of the rivet holes. There will be an exterior pair of iron stringers placed 3 ft. outside of the main stringers. These outer stringers will be proportioned to one-half the strength of the track stringers under the rails.

Highway Floor-Beams.—The highway floor-beams shall be proportioned to carry the floor weight of 550 lbs. (per lineal foot of bridge) and a live load of 700 lbs. per lineal foot of bridge. They shall also be proportioned to carry a concentrated load of 12,000 lbs. on one pair of wheels of six (6) feet gauge (in addition to the dead load), and the mode of computation which gives the greatest section shall be adopted—the specifications as to strains and rivet sections prescribed for the railway floor-beams shall be adhered to for the highway beams.

Bed Plates and End Supports.—Bed plates resting on masonry shall be so proportioned that the pressure on the masonry shall not exceed 35,000 lbs. per square foot for the main span, and 25,000 lbs. per squre foot for the smaller spans.

Friction Rollers.—The friction rollers, where used under the ends of a span, shall be so proportioned that the strains per lineal inch shall not exceed those determined by the following formulæ:

$\sqrt{540\,000 \times d}$ = lbs. per lineal inch in which "d" = diam. of roller in inches.

The east end of the 247 ft. span and the west end of the 53 ft. span will be supported from the underside of the upper chord on proper iron plates or saddles resting directly on the masonry of pier, the said pier having an archway through same for the passage of highway. This pier will be constructed by the railway company, of the proper height and form to suit the requirements of the bridge. The west end of the 247 ft. span and the east end of the 98 ft. span will be supported from the underside of upper chords on iron supports extending to the masonry of the present pier, on a level with the bottom of highway floor joists. This support will be constructed of wrought iron, strongly braced to resist lateral movement, and shall be so proportioned that the iron in it shall not be strained over 60 per cent. of the maximum strains permitted in forms of similar kind before mentioned. The space in the clear width and height of this structure, for passage of highway, may be not less than 13 ft. The plan of the top of the present pier, on which the proposed iron support is to be placed, is herewith furnished, and shows what portion of the pier can be occupied by the support without interfering with the present structure. The length of the spans mentioned contemplate placing the west end pin of the 247 ft. span over the exact centre of the masonry pier now built. If for the purpose of securing a more proper bearing in connection with the 98 ft. span resting on the same pier, it is desirable to reduce the length of the 247 ft. span a trifle, such reduction may be made, and in this case the 98 ft. span will be correspondingly increased in length.

Camber.—The several spans shall have a permanent camber of 1-1200th of their length. To more thoroughly understand the position of the several spans mentioned in their relation to the existing structure, see plan of same herewith furnished. The proposed bridge will be so located that its north truss will be north of and as close as convenient to the north chord of the present structure, and the south truss will be placed at its proper distance between the chords of the existing structure, and the centre line of the railway will be changed to suit the new structure. For convenience in raising, the grade of the track can be temporarily or permanently raised or lowered 6 in. The present long span is strengthened by two (2) supports built up from the river bed, and is strong enough to carry the additional weight of the new structure and necessary false works. Whatever false work may be necessary, and whatever changes may be required in rearranging the floor-beams, lateral and sway-bracing, etc., or any portion of the old structure, to permit the raising of the new, shall be done under the approval of the railway company's engineer, by and at the expense of the contractor, the timber and lumber necessary being furnished by the railway company, and the entire work shall be done without interfering with the passage of regular trains over the same. The railway company will remove the old structure on completion of the new. Any work or part necessary to complete the entire structure in all respects in a first-class manner, and which is not definitely specified herein, shall be supplied without extra charge by the contractor, and to the entire satisfaction of said railway company.

Tests.—A skilled inspector will be retained by the railway company, who will examine and test the iron at the rolling mill before it leaves for the shop, and who will have the shop work under his constant supervision, with full power of rejection whenever the specifications are not complied with. The engineer of the railway company shall have the privilege of selecting, at any time before the erection of the bridge, any of the manufactured iron members and submit the same to such tests as he may deem proper, and should any of the members thus tested fail to be of the standard demanded, this will be considered sufficient evidence that the iron for the bridge does not comply with the specification, and will cause its rejection. Reasonable compensation will be allowed for all material of good quality destroyed in making such tests. All bars subject to tensile strain shall be tested by the contractor, under the direction of the engineer of the railway company, to 18,000 lbs. per square inch of sectional area. On completion of the entire structure, and after the present structure is removed, the bridge, after being in current use for one day, will be tested with a train loaded approximately to the maximum specified, and after remaining on the several spans for thirty minutes and then removed, no permanent set should take place. For the purpose of determining the stiffness and stability of the entire structure longitudinally and laterally, it will be subjected to the following test, viz.: A train consisting of one engine, tender, one mail, one express, one baggage, three (3) passenger cars, and one sleeping-coach, or their equivalent, with air-brake equipment, will approach from the west and run on to the bridge at the rate of twenty-five miles per hour approximately, and when the engine is over the centre of the 247 ft. span the engine will be reversed and the air-brakes applied with sufficient force to slip the truck wheels, and no permanent change shall take place in the whole or any part of the structure.

(*To be continued.*)

*Paper read before the Liverpool Engineering Society, June 20, 1877.

The Kansas City, Burlington and Santa Fe engineers have the entire line located. Mr. Marsten, of Williamsburg, has the contract for grading twenty two miles. J. F. Harlan and A. W. Jones have contracted for the delivery of 5,000 ties, all hewn, M. B. Hoover for 5,000 more, and will furnish 130 000 feet of sawed timber for the trestle work. Mr. P. Bean, of Rock Creek, also has a contract for furnishing ties, while H. R. Rose is pushing the work on the stone work for the piers. The work will be prosecuted as fast as the weather will admit all along the line.

THE PRESIDENT'S MESSAGE AND THE DEPARTMENTAL REPORTS.

The chief event of the week in political circles is the President's Message and its accompanying documents. Although the Message is of much interest to all as citizens, it contains little of moment to the engineer. It is strong and full on the Southern policy, the finances, the civil service, and our foreign relations, and devotes considerable space to reviews and comments on departmental reports. No mention is made of the various subsidy schemes now before the public, nor is there reference to our public works.

The report of the Secretary of the Treasury, in addition to the usual financial statements, discusses at length the questions of resumption of specie payments, the remonetization of silver, and the adjustment of our coinage. It is accompanied by an able document from Mr. Knox, Comptroller of the Currency, and by the report of the Director of the Mint. In the comments on the various bureaus, we note that "during the year nineteen new light-houses, one new light-ship, one hundred and ninety-six new lights, and one steam fog-signal have been put into operation." Under the head of Coast Survey "good progress has been make in the general work of triangulation, topography, and hydrography, with commensurable results in the issue of charts for navigation." "One of the investigations proves that information regarding the approximate velocity and direction af sea-currents, at any hour of the day, may be compiled for the use of navigators," no doubt of great importance to our coasting vessels. "The variations of the magnetic needle have been noted," "and by elaborate discussion and collation with older observations, it has become possible to predict variations of the compass." We may add that this is a subject of great importance, the recent deplorable loss of the "Huron" being due either to compass defects or insufficient knowledge of its contents. It is recommended that public buildings now under construction be completed and only such new ones commenced as may be absolutely necessary.

The report of the Secretary of War, as was to be expected at the present time, contains an elaborate digest of the military situation with recommendations for the future and more effective organization of our army. Of the Signal Service he says:—

"The duties now devolved upon that service are, besides the instructions in military signaling and telegraphy, to conduct the observation and report of storms; to report on the average depth of water in the great rivers of the interior, and give notice of their dangerous rises; to give important assistance to the life saving service on our coast; and to construct and repair military telegraph lines. One hundred and fifty-nine stations of observation have been maintained during the year, and the deductions made from the information reported by them, now known as the 'Synopsis and Indications,' has been continued with gratifying results. A careful analysis of the indications thus published, and a comparison with the weather changes afterwards occurring within the time and district to which each has had reference, has given an average percentage of eighty-six and sixteen hundredths as verified."

No great storm has swept over the country without pre-announcement. The chief signal officer recommends the complete and permanent organization of the Signal Service as a distinct and independent arm of the service. The surveys under the direction of the Department are reported as follows:—

"In the survey of the northern and northwestern lakes under the engineer department, the triangulation has been carried from Westfield, N. Y., to Painesville, O. The topography and hydrography have been carried from Ashtabula, O., to Vermilion, O. The latitudes and longitudes of Mount Forrest and Cairo, Ill., have been determined, and assistance has been rendered in the telegraphic determination of the longitudes of Fort Fetterman, in Wyoming Territory, and Forts Stockton, Concho, and McKavett, in Texas. The difference of level between Lakes Michigan and Superior has been determined. The survey of the Mississippi river, which has been carried on by the officer charged with the lake survey, has been extended from five miles above Cairo, Ill., to a point eight miles above Columbus, Ky. Volume II., Descriptive Geology; Volume IV., Paleontology and Ornithology; and Volume VI., Microscopical Petrography, and the Geological and Topographical Atlas of the Geological Exploration of the 40th Parallel, have been completed during the year, and are now in the hands of the public printer. Volume I. Systematic Geology, and Volume VII. Vertebrate Paleontology, will soon be finished and ready for the printer. These reports will complete the work and publications belonging to this survey. The systematic survey of the territory west of the 100th meridian, which for several years has been carried on by engineer and other officers of the army, has been continued during the year in portions of California, Nevada, Colorado, and New Mexico. The continuation of this useful work is recommended.

We give the estimates in full as follows:

Salaries, contingent expenses, and postage	$1,193,884.00
Military establishment	31,593 270.68
Public works	7.957,077.76
Miscellaneous	2,371,210.80
Total	$43,115,443.24

The estimates submitted by chiefs of bureaus have, in some instances been considerably reduced. The Chief of Engineers estimated for the appropriations for fortifications, river and harbor improvements, surveys, buildings and grounds about Washington and the Washington aqueduct, the sum of $16 495,800. The estimate for rivers and harbors was reduced to $5.015,000, and for fortifications to $620,000; the total recommended for public works by the Secretary being $7,957,077.76.

Much of the report of the Secretary of the Interior is devoted to a vigorous discussion of the Indian Question.

The disposal of public lands during the year aggregated 4.849,767 acres, against 6,524.558 for the previous year. Of this 740,686 acres was by ordinary cash sales, 2.178,097 by homestead entries, and 700,791 acres were certified to railroads. The cash receipts for lands, fees, etc., were $1,452,969.23. The following table shows the extent of survey:

	Acres.
Total area of the lands, states and territories	1,814,769,920
Surveyed during the past fiscal year	10,847.082
Previously surveyed	702,725,655
	713 572 737
Remaining unsurveyed	1,101,197,183

After alluding to the timber depredations on our public lands in its legal and economical aspects, Mr. Schurtz grows deservedly eloquent in the following timely words:

The rapidity with which this country is being stripped of its forests must alarm every thinking man. It has been estimated by good authority that, if we go on at the present rate, the supply of timber in the United States will, in less than twenty years, fall considerably short of our home necessities. How disastrously the destruction of the forests of a country affects the regularity of the water supply in its rivers necessary for navigation, increases the frequency of freshets and inundations, dries up springs and transforms fertile agricultural districts into barren wastes, is a matter of universal experience the world over. It is the highest time that we should turn our earnest attention to this subject, which so seriously concerns our national prosperity.

The government cannot prevent the cutting of timber on land owned by private citizens. It is only to be hoped that private owners will grow more careful of their timber as it rises in value. But the government can take determined and, as I think, effectual measures to arrest the stealing of timber from public lands on a large scale, which is always attended with the most reckless waste.

Nowhere is a wasteful destruction of the forests fraught with more dangerous results than in mountainous regions. The timber grows mostly on the mountain sides, and when these mountain sides are once stripped bare, the rain will soon wash all the earth necessary for the growth of trees from the slopes down into the valleys and the renewal of the forests will be rendered impossible for ever; the rivulets and water courses, which flow with regularity while the forest stands, are dried up for the greater part of the year, and transformed into raging torrents by heavy rains and by the melting of the snow, inundating the valleys below, covering them with gravel and loose rock swept down from the mountain sides, and gradually rendering them unfit for agriculture, and, finally, for the habitation of men. Proper measures for the preservation of the forest in the mountainous regions of the country appear, therefore, of especially imperative necessity. The experience of parts of Asia, and of some of the most civilized countries in Europe, is so terribly instructive in these respects that we have no excuse if we do not take timely warning.

He suggests the following preventative and remedial measures:

First.—All timber lands still belonging to the United States should be withdrawn from the operation of the pre-emption and homestead laws, as well as the location of the various kinds of scrip.

Second.—Timber lands fit for agricultural purposes should be sold, if sold at all, only for cash, and so graded in price as to make the purchaser pay for the value of the timber on the land.

Third.—Agents should be provided to protect the timber, with authority to sell to local current demands and to see that no large areas are so stripped as to prevent natural renewal.

The Secretary recommends legislation to correct the evils of the desert land act passed at the last Congress. The Pacific railways are now before Congress for consideration, and public attention has everywhere been directed to the measures proposed. The Secretary demonstrates their ability to pay the amounts due the government. The facts given are of interest.

Omitting the Union Pacific and Central Pacific Railroad companies from the enumeration, there were at the close of the year 1876, eight hundred and nine (809) railroad companies in operation in the United States, owning 76,258 miles of road. Of these, only 181 paid dividends; 30 paid 8 per cent., 36 paid over 8 per cent., 115 paid under 8 per cent., and 628 paid no dividends. Of these 809 companines, the earnings of 31 were insufficient to pay "operating expenses," the earnings of 170 were insufficient to pay "operating expenses" and "interest," and 216 defaulted on their "bond interest."

The Union Pacific Railroad company, and the Central Pacific Railroad company, did better than ever before in the year 1876, notwithstanding the fact that all other railroad companies suffered from the great depression of trade and industrial enterprise.

Gross earnings	$31,073,803
Operating expenses	14,000,286
Net earnings	$17 033,517
Bonded interest paid	$6,612,815
Eight per cent. dividend on stock	7,299.000
	13,911,815
Surplus	$ 3.121,702

During the year 19,914 applications for patents were filed, and the number issued, including reissues and designs, was 14.459; the number of caveats filed was 2,685 and 1,098 patents were allowed but not issued owing to the nonpayment of final fee. The surplus from the business of the patent office was $105,921.49. When the department building, recently partly destroyed by fire, is reconstructed, its enlargement is recommended.

The report of the Postmaster General contains much interesting information, not however of an engineering nature. About 850,000 stamp and postal cards have been issued during the year valued at $26,525 836.47. The cost of the railroad service has been $9,053,936, and of the ocean service, $457,586.53. The total number of post-offices is 37.345, and the total number of men ployed, 52,654. The expenses of the department exceed the receipts by $4,854,180.82.

MEASUREMENT OF THE WORK ON THE NEW COUNTY COURT HOUSE.

A new board of Cook County Commissioners came into existence on the 3d inst., and we hope there are enough new and better men among them to leaven a body which was quite generally assumed by the public to always have its "eye on the main chance" in the letting of profitable contracts. Such seems to be a general belief, especially as regards the new Court House and we have previously had occasion to review their action in these columns.

Of late much has been said about the estimates of the amount of work done by the contractor, and especially in regard to the allowance of extras, for which the Commissioners have attained deserved fame. Accordingly, on the 13th ultimo, a committee of three experts, James R. Willett, L. B. Dixon, and P. B. Wight, was appointed to "report upon the measurement of work done by P. J. Sexton on the new County Court House." The members of this committee are well known architects of this city, and their report should at least have been entitled to a respectful consideration. But when it was read to the Commissioners, on the 22d ultimo, according to the city papers, quite a stormy scene ensued, in which much violent language and recrimination was indulged in by Mr. Egan, the architect, and others.

The chief cause of this was the discrepancy in the results found by the Committee and those previously given by Mr. Egan. The Committee found 1.934,680 less brick, about 10,000 lbs. more iron, and 5 00 cubic feet more stone, aggregating a difference of several thousand dollars.

The methods of measurement given in the report which follows will be found of interest to architects. It will be seen that the difference in the results may be attributed mainly to the difference in the data assumed for computing them, and no other question is necessar-

ily involved than that of judgment or the proper and fair method of estimating building quantities.

Mr. Egan is placed in a most difficult position,—a corrupt ring and grasping contractors on one hand and a suspecting public on the other. We sincerely regret that in his conversation before men he has not always so contained himself as to give the pulic no cause for criticism. That public can sometimes forgive mistakes of a sound judgment, but it cannot be expected to overlook either incompetence or malversation.

CHICAGO, *Nov. 22, 1877.*

Hon. C. C. P. Holden, Chairman of the Board of Commissioners of Cook County:

Sir.—We have the honor to report on the measurement of the work done by P. J. Sexton on the new County Court House as follows:

We received notification of appointment on the 13th. On the 14th we met at the new County Court House and received from you the following communication, which has been our guide in conducting the measurement.

"*To Messrs. Willet, Dixon, and Wight:*

Gentlemen.—You will measure all the brick work, stone work, and iron work executed at new Court House by P. J. Sexton, Contractor, and report the quantities in verified bill form to the Board of County Commissioners of Cook County, at their meeting, to be held Monday, November 19th, 1877, at 2 P. M. of that day.

Also report at the same time the quantities of materials on building site owned by the above contractor and intended for the work.

CHAIRMAN, COUNTY BOARD."

CHICAGO, *November 14, 1877.*

The same day a communication from J. J. Egan, Architect, was read to us by Mr. Hill. The substance of the communication was as follows:

(1.) That included in the work done by Mr. Sexton were 32 piers in the sub-cellar, namely, 8 piers under stairway at each end, 16 in all; 10 piers under main stairway, 4 piers under main vault at Clark street entrance, and 2 piers in engine room, all measured from top of footing course.

(2.) That all the brick work should be figured from a point 2 ft. 6 in. below the top of the iron beams of basement story.

(3.) That the height from top of basement beams to top of first story beams was 15 ft. 6 in., and the height from top of first story beams to top of second story beams was 23 ft. 6 in.

(4.) That in the architect's measurement all flues and chimneys had been measured solid.

(5.) That the cut stone of exterior walls is estimated to be one foot thick.

NOTE.—Mr. Egan came personally before the committee subsequently and explained that in addition to the amount deducted from the total thickness of exterior walls for stone facing as above, an additional amount of 10.000 cubic feet had been deducted from the brickwork on account of "extra stone supplied by McNeil for rustic facing not contemplated in plans."

(6.) That all isolated brick piers had been estimated at 1½ times their actual cubic measure.

(7.) That when piers come in walls, the walls and piers were measured together as walls, and one-half of the openings had been deducted; and

(8.) That fire-proof vault arches had been measured as solid from the spring line of arches.

The above statement was made to us as embodying the basis of the system of measurement employed by the architect in making his estimates.

(1.) With regard to the first statement, we will say that we have measured the 32 cellar piers and embodied a separate estimate of them.

(2.) With regard to the second estimate, we will say that we have included in the brickwork of basement story everything above a point 2 ft. 6 in. below the tops of the basement floor beams, the point at which the architect represented to us that Mr. Sexton's work commenced.

(3.) We have measured the heights of the basement and first stories, and find that they correspond with the measurement given to us by the architect in statement numbered (3).

(4.) We have included in the measurement of brick walls all the flues except the interior area of the steam boiler chimney 4x5 feet.

(5.) With regard to allowance for cut stonework in exterior walls, we will say that the system pursued by us has been to measure the brickwork *itself*, judging of its quantity by all the evidence attainable in the work done on the building. We have measured the brick backing wherever visible, and have measured such of the stonework as affords us evidence of its thickness. In coming to a conclusion on these points, we have only to say that we have been guided by our experience in such matters. What we give is an estimate only, and such as we are best able to make with our present knowledge. It may be added also that we have not been guided by the plans in this part of the estimate. There is a very considerable variation in the thickness of the stonework in the various walls, piers and buttresses, necessarily growing out of the nature of the design, as we we have ascertained by actual measurements. A separate statement is given of the brickwork in exterior walls of each story.

(6.) We have measured brick piers in the same manner as the architect, allowing one-half extra for additional workmanship.

(7.) We do not agree with the architect in the method of measuring piers and arches taken together. We measured the piers as stated in the last paragraph, and the arches as solid from the springing lines.

(8.) The fire-proof vault arches have been measured as solid from the springing line as done by the architect.

With regard to measurement of work done on the dome, we will say that we have had no data for the measurement of the excavation, earth filling or concrete, and accordingly have made no measurement of the same.

We have been informed by the architect and the contractor has exhibited to us written instructions to the effect that all openings in the dome superstructure are to be measured as solid parts. We have given as a separate item the cubic contents of the openings in dome, measured to the axis of the dome where half the openings are on the county side, to accord with the written instructions to the contractor to that effect.

Where the items of work which could not be seen are given upon the authority of information given by the architect or the plans of the building, it is so stated.

The items of brick-work are as follows:

Note.—Allowance is made for 15 bricks to a wall, the thickness of one brick, 22½ to a wall, a brick and a half thick, 30 bricks to a wall two bricks thick, and so on, this being customary builders' measurement.

	Bricks.
Sub-cellar	56,775
Basement, interior walls	2,035,000
Basement, exterior walls	1,115,000
Total	3.200.000
First story, interior walls	1,793,131
First story, exterior walls	1.335.702
Total	3.128,833
Second story, interior walls	394,415
Second story, exterior walls	36.292
Second story, total	430 707
Total bricks in whole building	6,816,315

No deduction has been made for bond stones in exterior or interior walls, it being the custom to consider that the amount of brickwork thus displaced as equal in value to the labor and loss of time attendant upon their being placed in position.

The items of stone work are as follows:

	Cubic ft.
Sub-cellar, bond and cap stones	626
Basement, bond and cap stones	452
First story, bond and cap stones	345
Second story, bond stones	55
Total	1,178
Dimension stone masonry.—	
At three main entrances	12.602
At rear walls adjoining dome	2,040
Total	14.642

The items of iron work in the building are as follows:

	lbs.
Wrought iron	709,600
Wrought iron	112,253
Note.—This last item is made up from a statement of iron work buried in the walls, furnished to us by Mr. Egan, and not seen.	
Total	821,853
Cast iron in sight	285.200
Cast iron plates in walls, as per Egan's statement	3.654
Total cast iron	288,854

The items of work done on the dome with the exception of concrete and excavation are as follows:

Dimension stone masonry.—

	Cubic ft.
Four footing courses buried in ground, measured from drawings of J. J. Egan	16,944
Superstructure measured to top of course, 6ft. 4 inches above top of basement beams	25,724
Total without openings	42,668
Openings if added.—	
East opening	2,911
North and south open to axis	3.231
Total openings	6,143
	48,811
Footings for seven piers buried in ground from dimensions given by J. J. Egan	1,704
Total of dome work	50,515

Estimate of material on the building site.—

The estimate here given of the amount of material on the site is evidently less exact than of that in the building.

Bricks, at least	75,000

Sand, lime and mortar not ascertained.

In making an estimate of rolled iron on the building site, we have not been able to measure all the beams, as many are partially covered, or lying in large heaps; in order to do so large piles of iron would have to be moved. We have therefore examined the bills of lading, furnished to us by Mr. Sexton, of all the beams, channels and plates shipped from Carnegie Bros. & Co. of Pittsburgh, and marked "P. J. Sexton, for Cook County Court House," the last one dated "October." Our estimate for this material is slightly within the balance of iron shown on bills of lading after deducting the amount set in the building.

	lbs.
Rolled iron on site, at least	500 000
Other iron work, at least	10.000

Of dimension stones on the ground intended for work on the dome, some of them dressed, there are 5,264 cubic feet.

Note.—With regard to methods of measuring bricks in one particular, as pursued by Mr. Egan and ourselves, it may be mentioned before closing that a copy of his detailed estimate of the brick-work has been furnished us,—it shows a measurement of 22½ bricks to the actual number of cubic feet in the walls. The walls generally overrun the figures on plans which are given in multiples of 4 inches—as 8, 12, 16, 20, 24, 28 and so on. The method of computation by which we have arrived at a result has been before stated as "15 bricks to a wall the thickness of one brick, 22½ to a wall a brick and a half thick, 30 bricks to a wall two bricks thick, and so on, this being customary builders' measurement."

We have received a communication in writing, under date of November 17th, 1877, from F. Baumann "as a committee of one of the Citizens' Association" containing a suggestion to consider a matter which does not come within the scope of our instructions. It is submitted herewith.

In conclusion we desire to say that the architect, Mr. Egan, has cheerfully given us all the desired information and loaned us his working drawings when requested, and that the contractor Mr. Sexton has afforded us every desired facility for conducting the measurement of work. The extent of the work has been such as to compel us to carry on the computations down to the last available moment. Respectfully submitted,

JAMES R. WILLETT,
L. B. DIXON,
Signed, P. B. WIGHT.

THE LEVEES.

The Chicago *Tribune* of the 3d inst. ventilates its ignorance of river hydraulics in a galloping editorial facetiously entitled "Levees and Levies." After dealing in a few glittering generalities which are without application, except for their sonorous qualities, it says: "While it is evident that the deepening of outlets already existing would furnish to owners of overflowed lands all the relief needed, it would be mere madness and folly to close those outlets and build up the river higher." And further that "the crevasse at Bonnet Carré and the other openings which can easily be made above and below New Orleans will at once provide all the relief that is needed."

It is quite sportive over the figures given by the St. Louis *Republican*, in which it is claimed that 17,760,000

acres would be redeemed for cultivation worth at $25 per acre, $144.000 000, and that half of them reduced to cultivation would produce annually 5.000,000 bales of cotton, 1 325.000,000 pounds of sugar, 100,000,000 gallons of molasses and 40,000,000 bushels of corn,—worth at present prices $400.000,000. "It is merely a proposition to take $100,000,000 from the many for the benefit of the few; to assist a great land speculation by filching the capital for it out of the National Treasury; and to tax every producer of cotton, sugar, molasses, and corn in order that the competition he now encounters may be increased." The latter part of this paragraph strikes us as being eminently generous, broad and statesmanlike. It says further,—"if there can be found individuals or companies rich enough and extravagant enough to make the Mississippi River an aerial highway, we shall interpose no objections; but on behalf of the people who pay taxes, and who have at present scarcely the money with which to pay them, we do object to saddling the work upon the National Government." And much more of the same tenor.

It is not necessary or desirable to enter upon a controversial argument. The *Tribune* is seriously misinformed. Had it read the report of the very able Levee Commission of 1874 it could hardly have fallen into so many errors in so short a space. Even were the system of outlets, given as a panacea by the *Tribune*, correct in theory, which is very doubtful, it would be quite inexpedient to adopt it. The cost of these levees as given by the Levee Commission was, we believe $45,000,000 and not $100,000,000 as represented. It is hardly necessary to state that when this improvement is undertaken it must be undertaken as a whole, for it is quite impracticable to make these improvements completely available for a long time when done piece-meal. It is doubtful if private capital can be made to undertake so large an enterprise, nor do we think the states interested would consent to have so great a portion of what would be their richest lands controlled by a corporation. As we understand the question, it is essential to the prosperity of the states interested that this improvement should be made. Devastated by a civil war and practically bankrupted by subsequent misrule, they are not in condition to raise the money by taxation, nor can they borrow it except at ruinous rates. The general government is not requested to make these improvements as a gift to the South. The states interested simply desire the government to undertake on a comprehensive scale that which they are now clearly unable to do themselves, expecting to repay the $45,000,000 with a low rate of interest, as soon as they are in a condition to do so. That it is a wise thing to do, and that the whole country will reap great and permanent benefit therefrom, we think is too patent to need argument at length.

On the 18th inst. Senator Conkling presented a petition to the United States Senate for an appropriation of $50,000 for a preliminary survey, by army engineers or naval officers, of the beginning of a transcontinental railway from the Republic of Liberia eastward one or two thousand miles to the Niger Valley, and to report upon the country, its population, products, etc., with a view to opening the market for our manufactures with Central Africa.

After several years delay, from failure to obtain jurisdiction over the ground for the lock and abutments of the proposed Davis Island Dam in the Ohio below Pittsburgh, the State of Pennsylvania at the last session of the legislature, through the efforts of the Chamber of Commerce of Pittsburgh, the necessary grants were obtained. Although there is much misjudged opposition on the part of the coal men, there is resonable prospect for the commencement of the work at an early day. This first experimental dam will, we trust, be only the preface to the radical improvement of the whole Ohio river. The people interested are awakening to the importance of the question.

An article has been going the rounds of the press entitled "A Very Narrow Gauge," "A Ten Inch Gauge Railroad" etc., giving a long description of the road from Bellirica to Bedford, Mass., a distance of 8½ miles, as designed by Mr. G. E. Mansfield. This has undoubtedly been mixed up with Mr. Mansfield's "Summer Heights & Hazelwood Valley Railway" of ten inch gauge, of which a description is given in Howard Fleming's book on "Narrow Gauge Railways," page 38. The Bellerica & Bedford railway is two feet gauge and we see in our issue of Nov. 24th notice of a proposed line on a similar gauge from Portland, Me., to Bridgeton, 40 miles.

The Commission appointed by the department at Washington to determine which is the front door of the Chicago Custom House, now building, arrived in this city on the 5th inst. It consists of F. R. Jackson, Superintendent of buildings, New York; Superintending Agent of the Post-office Department, M. O. Harrison, and Superintending Agent of the Treasury Deparment, Mr. Martin. We also notice that six hundred men are employed in the granite quarries of Hurricane Island, Me., preparing stone for the St. Louis Custom House and Post Office. Had the same quarries supplied the Chicago Custom House in place of the rotten Cincinnati stone, we think there would have been no question as to which facade was least disintegrated.

The Secretary of War, at the conclusion of his report, refers to the jetties at the mouth of the Mississippi, stating that with "the aid of the new dredge boat, if it is moderately successful, may soon enable Mr. Eads to gain a channel 22 feet deep for a width of 200 feet throughout the jetties, and the chances are quite favorable for the attainment of such a channel in the early stages of low water by help, possibly, of only an ordinary dredging-machine, and later, perhaps, even without such aid." Owing to there being an official channel of greater than 18 feet at mean tide through South Pass, operations were suspended at South West Pass on August 14, 1877. The deepening of the channel through South Pass is now very active in a certain portion of the pass. Congress will probably appropriate before long.

Heavy floods, doing many million dollars damage, in the states of Maryland, the two Virginias, and North Carolina occurred week before last. The Chesapeake & Ohio Canal and the James River & Kanawha Canal are both seriously damaged. Most of the railways are seriously damaged by washouts. The Virginia Midland lost the bridges over the Staunton and Rivanna rivers and a 900 ft. bridge at Amherst, besides several smaller structures. The Richmond & Danville road lost the Danville and Stanton brige. The Atlantic, Mississippi & Ohio lost two bridges below Lynchburg. The Cumberland Valley lost five spans at Williamsport, Md. At Weldon, N. C., the Petersburg and Weldon bridge and three spans of the Seaboard & Roanoke bridge are gone. Immense damage was done to private property by washouts and overfloods.

A List of the Rivers of England, laid before the House of Lords' Select Committee last Session on Conservancy, Drainage and Navigation Boards, gives the following as the rivers having catchment basins of above 1000 square miles: The Thames, which is 201 miles in length, and has tributaries of the united length of 463 miles; the Severn, length 178 miles, and tributaries 450 miles; the Trent, 167 miles, and tributaries 293 miles; Ouse (Cambridge), 156 miles and tributaries 212 miles; Wye, 148 miles and tributaries 223 miles; Nene, 99 miles, and tributaries 11 miles; Witham 89 miles, and tributaries 75 miles; Mersey, 68 miles, and tributaries 188 miles; Ouse (York) 59 miles, and tributaries 629 miles; Humber, 37 miles, and tributaries 55 miles; Tyne, 35 miles, and tributaries 174 miles. The catchment basin of the Medway is only three square miles below 1000; the length of that river is 69 miles, and its tributaries 62 miles.

At the time the Intercolonial was projected considerable discussion took place in Canada as to the relative merits of the St. John river route and the one since adopted. Some capitalists of New Brunswick, disappointed in that the route adopted left out the finest and richest portion of the Province along the St. John and its tributaries, determined to build a 3′ 6″ gauge to Riviere du Loup from Fredericton, the capital of the Province. They have already completed 123 miles to Grand Falls on the northwestern boundary of Maine, and next year it is proposed to extend it 38 miles to Edmonston (Little Falls) at the extreme northern point of Maine. This point is within 12 miles of the Quebec boundary and 70 miles from Riviere du Loup, and the route proposed extends by Lake Temisconata, a beautiful sheet of water 40 miles in length, about which exists a considerable population. This line would open up one of the most interesting, fertile and best timbered regions in the Dominion, and shorten the distance from Riviere du Loup and St. John from 461 miles by the Intercolonial to 277 miles. Quebec papers urge that the early completion by home parties of that portion of the line within the Province. As a commercial highway it is undoubtedly of much more interest to the people of the Dominion than the "running-to-nowhere" Intercolonial.

Some years since the public works of Ohio were leased to a company for a term of years at 10,000 per year rental. Last spring the lesees, claiming that the vacation of certain portions of the canal by the last legislature, as the abandonment of the Miami and Erie canal basin, would greatly damage their lease, gave notice to the Board of Public Works that if the obnoxious law was carried out they would throw up the contract on Dec. 1st. Accordingly, on that day, all the employés were discharged, and the works abandoned to the State. The Attorney-General has given the opinion that the lessees have no legal right to abandon the works, and advises the Board to take no official action whatever in the premises. The Board is very much embarrassed, not wishing to jeopardise the legal aspect of the case by assuming control, and at the same time fearing to lea e the canals without care, for millions of damages might take place in a single week from sudden freshets. The perplexing subject of what shall be done with the canals will come up for legislative action this winter, and much railway influence will undoubtedly be brought to bear to declare their entire abandonment. Meantime, the people along the lines are greatly excited over the subject, justly fearing that the strong competition, and consequent low rates, on all heavy freights as coal, ore, corn, etc., may be destroyed,

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We cull the following figures in regard to the business transacted to December 1st at the Buffalo office of the Erie Canal, from a statement of the Collector of tolls:

Shipments.	1877.	1876.
Total grain shipment—flour reduced to wheat—bush..	48,445,768	27,615,023
Barley malt—bush.....	209,986	215 233
Lumber—feet	79,782,688	57,213,201
Shingles, No.....	25,067,000	17,167,000
Stoves, lbs.....	84,787,229	53,719,369
Pork and lard, lbs.....	9,778,457	40,582
Number of loads cleared....	6,908	4,850
Tolls collected.....	$467 796.81	$583,569.83

The New York *Tribune* in commenting upon the subject suggests that this wonderful increase in business is largely due to the reduction of tolls and advances many valid arguments to show how the Empire State can well afford to make the canals as free as the Mississippi and its tributaries. It commends the enterprise of the Canadians who will have spent fifty million dollars when the present projects are complete, in making an "untrammeled ocean-way to Illinois." It concludes in this period: "Had we enlarged our canals ten years ago, the present enlargement of the Canadian canals would not now be in progress; had we made a timely reduction of our tolls it is more than probable that they would never have been constructed, but commercial, if not political annexation with full reciprocity, and all its attendant benefits, would have been the happy lot of both people."

The 4th inst. witnessed in Congress a quarrel between the Committee on Railways and the Commerce Committee, each claiming jurisdiction over the River and Harbor bill; one under an old rule in regard to rivers, but long since fallen into disuse, the other, that the Commerce Committee had reported the River and Harbor bill from the foundation of the Government. A significant feature of the discussion was that the representatives of both parties indicated their intention to have liberal River and Harbor appropriations.

Gov. Pound appeared before the Commerce Committee on the same day to advocate the examination of the head waters of the St. Croix, Chippewa and Wisconsin

rivers with a view to determine the practicability of constructing adequate reservoirs, for the purpose of controlling the floods and regulating the volume of water in the upper Mississippi to the needs of a low water commerce. The resolution was favorably reported to the House and adopted. Such an examination was made of the head waters of the Mississippi a couple of years since with results favorable to the construction of extensive reservoirs cheaply. We have no doubt that a great permanent improvement can be effected by the means of reservoirs and the damage from floods sufficiently diminished to pay the expense.

We also notice a live interest in the improvement of the Mississippi both at St. Louis and St. Paul. The executive committee of the River Improvement Convention met at St. Louis recently, and the result of their deliberations was reported to the Chamber of Commerce of St. Paul the 26th ult. to this effect:—To ask the national government for $2,000,000 to be expended as follows: From St. Paul to the head of the Lower Rapids, Montrose, $617,000; from Montrose to the mouth of the Illinois river, $233,000; from the mouth of the Illinois to the mouth of the Ohio river, $500,000, and the same amount from that point to New Orleans. It was also decided to establish headquarters in Washington, to be in charge of a sub-committee of three, for the purpose of securing these appropriations. A statistical memorial will be prepared by Col. Waterhouse of Washington University, St. Louis. St. Paul will send a delegation to the Convention to be held at Breckenridge, December 11, to urge upon Congress the improvement of the Red River of the North.

We have received the following estimates recommended in the reports for appropriation at this session:

Des Moines rapids	$ 35,000
Fort Madison (Iowa) harbor	20 000
Burlington harbor	25,500
River improvements opposite Dubuque	25,000
Rock Island rapids	50,000
Illinois river	145,000
Mississippi river, above the Falls of St. Anthony	5 ,000
Minnesota river	60,000
Chippewa river	60,000
Wabash river	100 000
Chicago river	150,000
Calumet Harbor	50,000
Michigan City Harbor	100,000

STREET TRAMWAYS.*

BY ROBINSON SOUTTAR.

Concluded from page 340.

Mr. Souttar, in reply upon the discussion, said, with regard to the complaint that his Paper contained no estimates, in the first place he had felt that estimates were to some extent misleading, and in the second place he had written a chapter on the subject, but had eliminated it as the Paper was getting so long. He regretted, however, he had not mentioned that a tramway would cost practically the same whatever system was adopted, and that it was a question of condition and not of system. In every well-constructed tramway there were three constant quantities, the concrete, the paving and the rails, making more than three-fourths of the total expenditure, the remaining fraction being represented by the longitudinal bearing, fastener, &c. Comparing tramways with timber bearings together, the cost would be practically the same, or a little more where cross sleepers were used instead of tie-rods, and comparing these with tramways having iron bearings the latter would naturally be more costly. In Mr. Kincaid's system, with chairs 3 feet apart, the cost was, at the present price of iron, about the same as that of timber. The longitudinal bearing of the Manchester tramway was in the proportion to a timber bearing of 256 lbs. of cast iron to 6 lineal feet, by 6 inches by 4, of timber, with an allowance for cross sleepers and fastenings, the ratio being practically as 3 to 1. Mr. Lynde had stated that "the cost of this system varied from about £2,000 to £2,300 per mile, according to the weight of metal and depth of paving used." The remark illustrated what the Author had said about the misleading nature of estimates. For, taking the amount of metal required for the work, at market prices it would be found that the margin could only cover the labour of excavating, laying the line, and reinstating old paving. The estimate neither included concrete under the tramway nor paving, and the rail was only 40 lbs. to the yard, instead of from 50 lbs. to 60 lbs., as usually adopted. Mr. Beloe had fairly set down the price of a properly constructed tramway at £4,500 per mile and with this price Mr. Lynde's system would appear to contrast most favorably; the fact being, however, that Mr. Beloe gave the price of a complete tramway, whilst Mr. Lynde gave the price of half a tramway. It could not be too clearly understood that the cost of a tramway was only slightly affected by the particular system under which it was laid, but materially by the weight of rail and quality of paving and concrete that the circumstances rendered advisable. Mr. Fowler's preference for a rail supported on a series of hard points, instead of on a continuous bearing, seemed incomprensible, as well as his preference for iron over steel. Mr. Cowper's remark, that the grinding of the rails caused by grit or sand was better resisted by steel than by soft iron, was justified by experience. Mr. Fowler was under a misconception with regard to the rail which the Author had introduced. There was no space between the fastenings, the timber was the extreme width of the rail, and a little piece was gouged out into which the fastener sank. The sinking of the pavement on the Glasgow tramways, noticed by Mr. Beloe, was probably due to the fact that an unnecessary quantity of sand, 2 inches, was laid under the paving, and not to any failure on the part of the bituminous concrete. The tramway described by Mr. Rapier would be useful as a means of reducing the friction of heavy vehicles, travelling at a slow pace, just as rows of flat stones were useful for that purpose. There were, however, points in the system which would render it unsuitable under ordinary circumstances, where a quick, rattling motion had to be endured; and there was nothing in its design calculated to diminish the cost of repairs, as compared with other tramways. Mr. Lawford disagreed with the conclusions on the subject of asphalt, and quoted an instance of asphalting in London. The piece referred to was done under the Author's superintendence, and he would therefore gladly defend it; but the fact mentioned, that it had been found necessary to put stone on each side of the rails, spoke for itself. Mr. Lawford said he should like to see a street tramway laid for £1,500 per mile, and then gave details of a tramway he had laid for less than £1,400 per mile. Of course a tramway could only be laid at the price mentioned under exceptionally favorable circumstances, and in the lightest possible manner. Mr. Perrett would find that "the immediate cause of the rapid loosening of the spiked rail from the sleeper" was the breaking of the spikes at the neck. Perhaps the construction of the car had something to do with this; but the Author thought it would generally happen when the rail became so worn that the wheel flange could touch the bottom of the groove. Mr. Perrett had contrasted some of the arguments in favor of a combined engine with some of the arguments in favor of a detached. For the former he claimed adhesion, handiness, and steering capacity. There could be no doubt that the combined engine was superior in the matter of adhesion. On the second point, the detached engine would be made handier to work than the combined engine in everything except shunting. On the question of steering there was little to say. Steering gear would complicate the car, and would be useless at night. It was questionable if the power of steering would be of any practicable valed. In dealing with repairs, Mr. Perrett had misunderstood the Author. In saying that a slight accident would cause £500 to lie idle, an accident to the car was meant, not to the engine. Whilst the Author felt that the question might be still more fully tested with advantage, he thought that every day showed more clearly that the detached engine was the tramway engine of the future. On the question of the pneumatic cars, whilst recognizing the difficulties in the way, the Author was scarcely so hopeless as some of the speakers. He was sorry that Mr. Scott Moncrieff had found it impossible to be present at the discussion, especially as he believed an arrangement had been concluded which would enable the method to be fairly tested in the course of the next year.

Mr. Stephenson, President, said he had hoped that more distinct information would have been elicited in in regard to a better class of engine. The improvement of the rail would take place in the course of time. Some years ago he had occasion to examine the details of one of Mr. Grantham's engines, and he was strongly of opinion at the time that a separate or detached engine would be the best. He had carefully watched the progress of the engines, and although he was not prepared to give the cost of working, the more he had gone into the subject the more satisfied he was that a detached engine would ultimately come into use. He had no interest in any of the engines, and his opinion was, therefore, an unbiassed one. Mr. Longridge had objected to the detached engine on the ground that it had only its own weight to deal with for adhesion; but if he had looked at the matter more closely he would have seen that a detached engine could be made to take certainly half the weight of the carriage. It might be placed in the middle of two carriages, one-half of each carriage resting upon it, by a joint devised for the purpose. He was not prepared to admit that the old stock could be guaranteed for the proposed new tramways. He was glad that the subject of tramways had been discussed; and every one would desire that the sufferings of the horses might be relieved, even if the pockets of the shareholders were not filled to the extent they were at present.

Mr. Deacon remarked through the Secretary, that for many years he had given attention to the subject of street tramways. Before making any recommendation with respect to the proposed reconstruction of the existing lines in Liverpool, he had visited all the more important tramways in this country and many of those on the Continent, and had studied the available literature on the subject. He had endeavored to approach the question with a mind unbiassed by the railway practice, or by the peculiar forms of street tramway which had in some degree grown out of that practice. His investigations had beeen completed with a strong conviction that no existing system of laying street tramways was entirely suited to the exigences of the irregularly built and crowded streets of the principal cities and towns of this country. He thought inventors had not apprehended the true nature of the difficulties to be overcome before municipal authorities and the owners of ordinary vehicles could fairly be expected to approve of tramways. The inconvenience to ordinary vehicles, caused by cars having no power to move aside, was very great, and though not inevitable in a mechanical sense, it must be admitted as a necessary evil when street tramways were allowed at all, for nothing but confusion would arise if ordinary vehicles had the power to cause heavy tramway cars to leave the rails. But the evils of street tramways were due not only to the inevitable tramway car, but to the existance of the permanent way. This permanent way involved, for each line of tramway, four longitudinal joints between materials of different hardness. It was well known to be impossible, in the ordinary mode of paving to prevent the formation of a groove wherever a longitudinal joint existed, even when the materials on both sides of the joint were the same. It was still less possible when the materials were of different natures. If, however, a course of setts were sawn in halves parallel with the street, and the sets were so bedded that the sawn joint remained close, the bearing surface of the setts was not reduced and no greater wear took place at the joints than elsewhere. Again, if near the line of such a joint the upper edges of adjacent setts touched each other at the transverse joints, there would be more bearing surface at and near the longitudinal joint than elsewhere, the intensity of pressure from traffic would be reduced, and instead of a groove forming, the wear would be actually slower than elsewhere. Having applied the same principal to the courses of setts immediately adjoining tramway rails, his expectations had been completely realized, after seventeen months' trial, under the most severe conditions.

During the reconstruction of the tramways in Liverpool the streets in which they were laid were being repaved and provided with new foundations from curb to curb. The vehicular traffic was entirely suspended, the old foundation was removed, and a bed of Portland cement concrete was laid and finished with a perfectly smooth surface, which was allowed to stand for ten days

*From Proceedings of the Institution of Civil Engineers, London.

or more before the paving was commenced. Directly upon this the longitudinal sleepers rested. The rails were held down by bolts passing through the sleepers to plates beneath the concrete at every 3 feet, and these bolts could be tightened at openings in the sides of the sleepers. The setts next the rail were of durable stones, and were carefully dressed in such a manner that, unlike the other setts which were bedded upon ½ inch of sand, they rested firmly upon the concrete, while their edges touched the edges of the rails, and their sides near the rails touched or nearly touched each other. Being laid alternately, and accurately guaged in all dimensions, they could be drawn and replaced with similar setts without disturbing the surrounding pavement The joints of all the setts were filled with gravel from ¼ to ⅜ inch in diameter, among which a mixture of boiling pitch add creosote oil was poured.

It was generally known that in streets of moderate traffic the wear of a tramway rail, caused by the tramcars, was insignificant in comparison with that due to the ordinary traffic. In the rail now in general use, 4 inches wide, a breadth of 1⅞ inch was covered by the tread of the wheel, 1¼ inch being occupied by the groove, while the remaining width of ⅞ inch was only useful for strength and as a guard for the flange of the wheel and the pavement of ths horse track; but this extra metal gave only lateral strength, which was not required, while the whole surface, whether superfluous or not, was constantly being worn down by the ordinary traffic. It was therefore obviously important to make the rail as narrow as possible. A reduction of width would also lessen the danger to horses, and the incentive which the drivers of ordinary vehicles felt to occupy the rails, and thus wear them and the adjoining pavement unduly. If the groove were placed in the centre of the rail and the tread on both sides, not only would the pressure be better distributed, but the whole surface might be utilized, and with the same total width of tread the width of the rail might be reduced from 4 inches to less than 3⅛ inches. Where, therefore, as in the case of street tramways, a groove was desirable, it was difficult to understand why it had never been placed in the centre. Mr. Souttar had referred to the central groove which Mr. Deacon had adopted, but had not stated the reasons for its adoption, though he had expressed fears that the friction would be greater, owing to there being no escape for mud or gravel; that the tendency of cars to run off on curves would be greater; and that the centre flanges on the car wheels would be weaker and more liable to chip off than the side flanges. The mud difficulty was common to all grooved rails. In the side grooved rail, if there was enough mud to be pressed out, part escaped on the free side, part under the tread of the wheel. In this case it had twice as far to travel before it was liberated from the rail as in that of the central groove where it all passes beneath the two half treads; so that for the same quantity of mud the two cases were almost similar It was usual to remove mud periodically by an instrument designed for the purpose, and in order to avoid friction due to the squeezing out of mud during the intervals there was no objection to the groove being made deeper than usual. The Author of the Paper had given no reasons for his belief that the cars would run off the line more readily because the grooves were central; and as the flanges of the wheels were not altered in depth there was no mechanical reason why they should do so. The Author thought a side flange would be stronger than a central flange; but this was opposed to the known conditions of strength in projecting portions of castings. In cast-iron wheels the central flange with fillets on both sides would certainly be stronger than the side flange with a fillet only on one side; while any method adopted in the case of the side flange to prevent it from becoming brittle by too deep chilling, was available in the case of the central flange.

In straight lines the central groove might with advantage be reduced in width. The flanges of tramway wheels were generally only ½ inch wide, while the grooves of the rail were more than 1¼ inch. He believed that great extra friction, due to transverse motion of the car, resulted from this; but the wide groove was stated to be necessary to hold mud. This might be a good reason for deepening the groove, but it could not, he submitted, be a good reason for widening it. Some allowance must be made for defective gauging of wheels and rails, but his own observations had led him to believe that ¾ inch for the width of a groove was ample. With such a central groove a rail 2½ inches wide would have greater bearing surface than the present rails 4 inches wide.

Among the most expensive parts of a tramway to maintain were the points. Their chief cause of weakness arose from the want of sufficient area of tread when a wheel approached the point and bore upon its narrow surface only. This surface was rapidly worn down, and the wheel, on coming in contact with the tread of the rail beyond the point, had to mount on to it, and thus produced the inclined plane noticeable in all tramway points after a short period of use. The central groove and flange with the double tread obviously removed this difficulty. In Liverpool he had, unfortunately, to consider the fact that the side-flanged wheels on the old lines must at first run upon the reconstructed portion also, and the width of the rail had therefore only been reduced from 4 inches to 3¼ inches.* For rails of the usual width the recessed dog-hook fastenings used by the Author had obvious advantages over the projecting dog-hook fastenings; but if used with the narrower rails, which he thought desirable, they would involve a greater reduction of the base of the rail and of the width of the sleeper than was consistant with stability. Another objection to such comparatively light fastening was their greater number and consequent interference with the pavement before they could be reached.

Mr. H. Hughes observed, through the Secretary, that the locomotive designed by his firm had been tried against a compressed-air engine at Glasgow. The former engine had two cylinders, each 6 inches in diameter, with a length of stroke of 12 inches; the average pressure in the cylinders being 50 lbs. per square inch; the distance run was 31 miles; the time occupied in the run five hours and one quarter, and the speed six miles an hour. The compressed-air engine had two steam cylinders for pumping, each also 6 inches in diameter with a length of stroke of 14 inches. The air was compressed to 350 lbs. per square inch; the average working pressuure was 50 lbs per square inch. The distance run was 12 miles, and the speed 6 miles an hour. The steam engine was nine hours compressing the air.

He thought the reason why some engineers were favorable to an engine placed in a car was, that they underestimated the power required, It had been found that the weight of a well constructed locomotive engine with all proper appliances, and to be safe for a tramway journey, without taking in fuel or water, would be 6 tons, a sufficient weight for adhesion. But if such an engine were placed in the car, the total weight on the four wheels would be 10 tons, a load too great for many tramway rails. The separate locomotive was a simpler way of distributing the weights on the rails, and of extending the wheel base without diminishing the facility of passing round curves. Moreover, in all cars containing their own engines which had yet been designed the wheels were not coupled, thus dispensing with the merit to which their inventor laid claim.

Mr. A. O. Schenk remarked, through the Secretary, that in trying to find out the soundest mode of construction for the permanent way of street tramways, the probable substitution of mechanical for animal power, at no remote date, should be prominently kept in view. If this were affected, any defects in existing arrangements would be intensified, when the traction was obtained by the adhesion due to a concentrated load on two or more pairs of wheels. Under these conditions, the system, in which the rail was a mere bar laid flat, dependent for its stability on the permanence of the connections that united it with its continuous longitudinal support, must give way to a mode of construction better adapted to the new method of traction. In this arrangement the rails, under the action of passing loads, tended to slide upon the upper surface of the timber, but were resisted by the fastenings, these being thrown into direct shear, in the course of time, and under the frequent repetition of this action worked loose. If this was the case now, what might be expected when a thrust of considerable magnitude was exerted along the rail dependent on the weight on the driving wheels and the state of the rails? Further, the longitudinals had little lateral stiffness; and when it was borne in mind that heaver vehicles came on and went off at all angles, it would be seen that the paving adjoining the rails stood a poor chance of mintaining its position, being constantly under the action of severe shocks. The breadth, too, of the longitudinal being limited to 4 inches or thereabouts, the load was distributed over a small area. This also tended to shorten the life of the road. The system known as "Barker's," in which the longitudinals were of iron possesses no advantage over wood in this respect, and, being of a harder material, would be more injurious to the foundation; while it also appeared to have disadvantages peculiar to itself—such as the impossibility of getting a uniform bearing between rough surfaces of wrought and cast-iron over a continuous length, and the want of surface in the cotters which secured the rail to the support. It would seem, then, that the system which would be permanent must be one in which the above-mentioned defects were avoided or over-come. Mr. Beloe suggested that a good road might be made by a rail of common bar-iron section attached to cast-iron chairs, fixed in their turn to cross sleepers. Such an arrangement had been devised by him some months ago. To this plan the following advantages were attached:—(1) A rail was used which had vertical stabitity enough to carry the load without continuous sleepers. (2) The load was distributed through a broad-based chair over an area which was limited by considerations of expense. (3) A rail conld be taken out and replaced without interfering with a single paving sett. (4) No iron fastenings were employed, and the evils of corrosion and enlargement of holes were avoided. (4) Less smooth iron was exposed on the surface of the street than in any other system. (6) The form of rail was adapted to the formation of points and crossings, and was well fitted for bending round curves limited in radius by the width and angles of streets. (7) It compared favorably in first cost with the best of existing systems, while in subsequent maintenance a considerable reduction might be looked for.

*Since this was written about 1,000 yards of the most recently constructed tramway has been opened to traffic in Liverpool. The side-flanged wheels are now running in a perfectly satisfactory manner on the central grooved rails, as well as upon the old side-grooved rails; but these wheels are being rapidly replaced with central-flanged wheels which, until the lines are entirely reconstructed, will also run on both kind of rail.—*G. F. D.*, Aug. 4. 1877.

[Communicated.]

THE late accident at the Gault House, in Sterling, Ill., where one of the guests was fatally poisoned by inhalation of gas from an open gas-burner, brings to mind the statements of unusual danger incurred by using illuminating gas made in part from anthracite coal, and of the prohibition of its use in France.

In this especial form of gas (which is technically known as "water gas,") made by passing steam through anthracite coal, or coke at a high heat, it is alleged that the poisonous element (carbonic oxide gas) is present in much larger quantities than in gas made in the ordinary way from bituminous coal. In the latter gas, fatal results from carelessness or mismanagement of burners are not infrequent, but in a large majority of cases the poisoning is so slow that the sufferer is rescued before life is extinct.

With a gas containing a larger proportion of poisonous constituent, death is quickly produced, and the chances of rescue are very slight.

Carbonic oxide is so fatal a poison that two per cent. of it in an atmosphere is considered sufficient to cause the death of those inhaling it, and gas companies furnishing an undue quantity of it in their illuminating gas should be held responsible for the results.

Gases made from oil and resin are quite free from this noxious quality and could scarcely produce fatal results by any possible inhalation; but as it seems to be inseparable from coal gas people cannot be too careful to see that burners are properly shut off before they retire.

Lives enough have been lost by carelessness in this way, but if gas companies are permitted to furnish gas made from anthracite coal and containing an unusual amount of carbonic oxide, the still greater number of lives rescued, by any of the many chances that time so often brings, must hereafter be added to the list of lost.

THE name of the port of Brashear, La., was changed to Morgan City by the House on the 1st inst.

[From the Providence Journal.]

MOUTHS OF THE MISSISSIPPI.

Knowing that the intelligent community which reads your paper is interested in any work of a national character, I ask for space in your columns to give some facts relating to the jetties now being constructed at the mouth of the Mississippi river.

Taking it for granted, that your readers are already somewhat acquainted with the subject, I will confine myself to a few special points of interest connected with the present condition and prospects of the jetties.

In regard to the depth of channel that exists at present through the jetties, it will be sufficient to state that on the first day of November, this year, the steamship City of Bristol, of the New York and Liverpool Inman Line, passed through the jetties without detention and without touching. Her draught was 21 feet and 8 inches, the tide at the time was 2½ inches below "average flood tide," which is the plane of reference established by the United States engineers.

It may now be generally understood, that the delay in obtaining the deeper channels demanded by the contract between Capt. Eads and the United States Government has been caused mainly by the difficulties which have been met with in deepening the river shoal at the head of the Passes.

First, there was not a full knowledge and comprehension of all the conditions existing, nor of their relation to each other, and to the channel, which it was necessary to make into South Pass; secondly, it was necessary that the works should be partly tentative in their nature, and this fact demanded considerable time in which to observe their effects; thirdly, many months were consumed in building these extensive works which would control the whole volume of the river. All these causes have delayed the formation of the channel through the bar at the Gulf, where the jetties are located. Without entering beyond a few explanations into the discussion of this most difficult and interesting problem of river hydraulics, on which a treatise could well be written, we simply refer to the fact of its existence and of its intimate relation to the channel through the jetties.

There are conditions existing of so subtle a nature, with relations so obscure and yet so entirely dependent upon each other; there are hidden causes, that operate so quietly and easily, to change existing conditions and to destroy the equilibrium of natural forces; there are at times such unlooked-for results from the works constructed, and there are so many occult principles and unknown laws in the flow of water moving in immense volumes that are elucidated by these results, that in the end, one of the most useful and interesting histories may be written, that will record in detail all the steps which have been taken to persuade the waters of the great river to go where man directs.

With all the interest that may attach to the subject in the mind of a disinterested person, who views it all calmly from a distance, yet by those who have not only their reputations but their financial prospects at stake in the success of these jetties, it is deeply regretted that the completion of the work and the securing of the maximum channel has been delayed so seriously, and the success of the enterprise endangered by what appears now to have been false economy, which decided upon the improvement of the South Pass rather than of the Southwest Pass.

To improve by the force of river currents, a shoal which lies as a great middle ground between the two main outlets of the river, is one of the most difficult of undertakings. To induce the river to leave the channel in which it has flowed for ages, and to seek a new and untried one, is in opposition to its conservative nature; it hesitates long, and is very loth to leave the old ways for the new.

It is necessary to show this almost sentient monster that there are sound hydraulic reasons for changing its ancient habits.

All the works that are built in the funnel-shaped mouth of South Pass, have a tendency to throw a part of its volume into the two large passes, which stand right there with their great, hungry mouths to take every drop that comes within their reach.

To avoid this result of our works, it has become necessary to hold the sections of these passes *in statu so* by laying on their beds a sill of willow mattresses, from our works, at the head of South Pass, to the east and west banks of the river.

The total length of th se sills is about one mile and a quarter. They are simply the foundations of more extensive works of the same kind, by which we expect to control, slowly but surely, the whole river volume, and draw from it what South Pass needs to obtain and maintain, a channel, thirty feet deep and 350 feet wide, to the deep waters of the Gulf of Mexico.

Another subject which we wish to refer to, especially is the "re-formation" of the bar in front of the jetties; that "re-formation" that has been held up by some of our friends, as the great, final and grand obstacle to our success.

In the earlier stages of the work, it was the impossibility of securing even a twenty-foot channel that troubled them; the absurdity of our expecting any such result was so clearly patent to their minds, that they thought their arguments unanswerable, and convinced themselves at any rate of our prospective failure; but the 20 foot channel came, then the 21, now nearly the 22, and through the jetties a broad, deep channel from 24 feet to 95 feet deep, has made its appearance, and has thus steadily and surely furnished us facts for our arguments that 30 feet would surely come.

Of late we hear but little of the absurdity of our intention to obtain a deep channel; but now it is *that bar*, that *new* bar that is to form so rapidly, close up the jetty outlet and bring disaster upon the whole enterprise!

Well, it is now two years and a half since we laid the first willow mattress on the South Pass bar. The same enormous volume of mud and water has flowed out through the jetties that formerly spread out like an open fan a mile and a half in width, and in addition to it nearly four million cubic yards of sand and clay have been excavated from the shoal at the head of the Pass and from the channel between the jetties and thrown out into the gulf.

The arguments on either side have facts now, or the absence of them, to prove or disprove the conflicting theories. The time has come when the American people who are to pay for this great work can demand the facts, that they may know whether all the money expended and to be expended, is irretrievably lost in a mud bank that will pay no dividend to its depositors, or will result in a deep and permanent outlet for the Mississippi Valley.

In the limited space allowed us in your crowded columns, we cannot give all the details connected with the facts in our possession. If we could do so, and illustrate them by maps and diagrams, we could show to the satisfaction of the most obstinate opponent of the jetties that the reformation of the bar, as prophesied, is a myth. We will beiefly allude to the facts and give general results only.

In May, 1875, the United States Coast Survey, under the direction of Mr. H. L. Marindin, one of the most efficient and careful assistants in the department, made an accurate and detailed survey of the South Pass bar. This survey extended into the Gulf about half a mile from the outer crest of the bar.

In October of this year, (1877), we made a survey covering the same ground. The lines of soundings were run in the same manner as those of Marindin. The general and detailed plan was similar to his. The work was plotted on the same scale. His soundings were increased by one foot and eight-tenths, to bring his plane of reference up to ours.

The whole area in front of the jetties was then divided into squares of one hundred feet. We took it for granted, that between any two soundings of his and also of ours, the slope was uniform. Depths were thus obtained for each corner of each square.

A skeleton was made, on which these squares were drawn; the calculated depth at each intersection was put down in one color for Marindin's survey, and in another color for ours, and we then had the data carefully arranged for calculations by the prismoidal formula. This plan was adopted on account of the unequal spacing of the soundings and, while it is open to the charge of interpolation, it gives, under the circumstances, the most accurate results.

The depths having thus been put down, the skeleton was subdivided into larger areas and figures. Using the one thousand feet, between the present end of the jetties, as the base of a rectangle, the jetty lines were produced into the Gulf 2500 feet.

This figure was divided again into smaller rectangles of 1000 feet by 500 feet.

The large rectangle was enlarged by adding 1000 feet to the width at the outer end (500 feet on each side) but retaining nearly the same width at the end of the jetties. Then a larger figure still was drawn in the same way, and so on, until the final figure embraced the fan-shaped area of the discharge of sedimentary matter issuing from the jetties during high river.

The calculations show that over the rectangle (1000 feet by 500 feet) lying immediately in front of the jetties and adjacent to their ends, there has been an average deepening of four feet and two inches.

This is the identical ground over which the bar reformation was to take place so rapidly. The rectangle first spoken of, namely, 1000 feet by 2500 feet, we will call A; the next larger figure B, the next C, and so on, each one embracing all the preceding. The result of these calculations is given in the following table:

Letter of Combination.	Area of Combination in square feet.	Mean gain in depth on Combination since May, 1875, in ft	Quantity of material secured in Combination since May, 1875, in cubic yards.
A	2,500,000	0.878	81,341
B	4,000,900	0.727	107,690
C	5,300,000	0.990	195,609
D	6,520,000	1.144	276,328
E	7,770 000	1.166	335,572

A map exhibiting graphically the changes that have taken place, shows clearly that there are well defined areas of scour entirely across the whole mile and a half investigated, and at right angles to the end of the jetties.

We do not need to go beyond this map to prove the existence of a well marked and almost constant littoral or shore current of salt water, sweeping under the fresh water, and not only carrying to one side the vast amount of sediment thrown out of the jetties. but even digging down and cutting into and carrying off much of the original outer slope of the bar.

The surveys and calculations made recently by Capt. M. R. Brown, U. S. Engineers, who is detailed by the Secretary of War to inspect the jetties for the government, corroborate the statements we have made,

In his report of July, 1877, to the Secretary of War, he compares his survey of June, 1876, with that of June, 1877.

We quote some passages that refer to this special subject, and which are found on pages 26, 27 and 28:

"On sheets No. 4 will be found the results of a survey, in June 20th to June 22d, 1877, of a mile or more beyond the ends of the jetties, and for a considerable space on either side."

"The subject of fill and scour beyond the ends of the jetties has occupied so much attention that I have carefully compared the results of the survey of June, 1876 with that of June, 1877, and for the purpose have divided the whole area, comparable by means of the two charts, into twenty-one divisions."

"The fan-shaped areas are, of course, those of the most pressing interest when investigating the influences of changes in the immediate future of commerce."

"Taking into account all the divisions except 1, 7, 13 and 21, we find that the scour in the year was 1.145,976 cubic yards, equivalent to a scour of 1 3109-10 000th feet, or 1 foot 3.7 inches over this latter area."

E. L. CORTHELL, *Resident Engineer.*

PROVIDENCE, R. I., *Nov. 20th, 1877.*

At a recent meeting of the Canal Board of New York the propositiou to sell the Crooked Lake Canal was reconsidered. A proposition from Gen. Genet to keep the Champlain Canal free from ice during the winter was referred.

A Liverpool paper credits Mr. W. H. Vanderbilt with a plan to establish a steamship line between that port and New York, presumably to run in the interest of the New York Central. It is said that the formation of a company is well under way.

Gen. G. T. Beauregard telegraphed Gen. J. G. Barnard on the 27th ult. as follows: "Spent yesterday and to-day with Capt. Eads witnessing the operations and testing the results of the dredge boat Bayley; saw 2,346 cubic yards removed from the crest of the bar by her in 16 hours 10 minutes working time. The soundings show very satisfactory results."

GENERAL INTELLIGENCE.

☞ We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.

GAS AND WATER-WORKS.

The new system of water works just inaugurated in La Crosse was quite recently completed, and is satisfactory.

The Pawtucket Water Works Commissioners are considering the practicability of adopting water meters for all services.

Rochester, N. Y., papers are rejoicing that Geo. D. Lord's suit against the city for $600,000 over and above the contract price for the water works he constructed, has resulted in a verdict for the city.

A gas meter at Indianapolis exploded recently. The works were new and designed for making "water gas." The gas meter was 87 feet in diameter and 27 ft. deep, constructed of boiler iron. Damage $20,000.

The Vergennes Machine Company, of Vergennes, Vt., manufacturers of Flander's pumping machinery, are completing two sets of pumps, for the city of Ottumwa, Iowa, whose capacity will be 3,000,000 gallons of water each per day.

The Chapman Valve Manufacturing Co., of Boston, Mass., have just made a shipment of valves to Zurich, Switzerland, being the fourth during the present season, and attributable to their display at the Centennial Exposition at Philadelphia last season.

The amount of water pumped up for consumption in Cambridge, Mass., during Nov., was 78 425.700 gallons, an average of 2,240,734 gallons per day. A considerable amount of four, six and eight inch pipe has recently been laid, and the reservoir has been thoroughly cleansed.

At a regular meeting of the Allegheny (Pa)., Water Committee on the 1st inst., the Supt. of Water Works and City Engineer reported the reservoir in bad condition the north bank having slipped and considerable leakage taking place. The west compartment will be used while extensive repairs are being made.

Among the intended applications to the Ontario legislature, this winter, is for an act to empower the corporation of St. Catharines to raise $50,000 to complete the water works and $72,000 to carry on civic improvements; also an act to drain 5,000 acres of land covered by Lake Scugog; also for authority to construct a railway from Guelph, Listowel, Harriston or any intermediate point to Owen Sound.

The Chapman Valve Manufacturing Co., of Boston, Mass., have just completed their contract for supplying the New Pawtucket, R. I., water works, with 350 gates from 4 to 24 inches in diameter, and the Wilmington, Del., water works extension, with 250 gates and 125 hydrants. They have also just closed a contract for supplying the Cocheco Manufacturing Co., at Dover, N. H., with the entire outfit of water gates, hydrants, and steam valves for their new mills.

The Lawrence, Mass., water works, have recently purchased of the Union Water Meter Co., of Worcester, Mass., six 8-inch, and one 6-inch Rotary Piston Meters, to be used for measuring the water supplied to the principal manufacturing corporations of that city. Five 8-inch meters of the same manufacture are also in use for the same purpose by the corporations at Manchester, N. H., and one of the same size at the Worcester, Mass., water works. These are the largest water meters in use in the United States.

We learn from the Virginia City, (Nev.) *Enterprise* that the survey for the direct road to Reno, a distance of 42 miles which it is expected to cut down to 33, is complete. The matter will be settled next spring.

RAILROADS.

The first spike was driven on the Bellaire & Southwestern R. R., narrow gauge, at Bellaire, O., on the 27th ult.

The project is revived of extending the Housatonic R. R. from Pittsfield, Mass., through Lanesboro, New Ashford, North and South Williamstown, and on to Adams.

The quickest piece of railway construction on record was that of the Pennsylvania & Atlanta City road—fifty-five miles built in sixty-seven days.

There are passenger carriages on the little Festiniog R. R. (23½ inch guage) that have seat room for fifty persons, and yet weigh only six and one half tons.

The town of Georgetown, S. C., has voted $50,000 in aid of the Georgetown & Camden Railway, and the county has voted $100,000. The projected line is nearly 110 miles in length.

It is proposed to build a railroad from Meadville, Pa.. westward by way of Shermanville and Conneaut Lake to a point on the Erie & Psttsburgh road near Linesville, a distance of about 14 miles.

The officials of the various roads entering Dayton, O., met at that place on the 27th ultimo to take definite action in regard to the construction of a union depot. It will probably be built.

The completion of the Montreal, Ottawa & Occidental Railway to Hull, opposite Ottawa City, will transpire in a few days, it being expected that trains will be running regularly from Hull to Montreal in the beginning of the coming month.

The Hawk's Nest & Gauley River Railway company has been organized to build a railroad from the Chesapeake & Ohio at Hawk's Nest, W. Va., by Mill and Rich creeks to the Gauley river, aud down that river and the Kanawha to Kanawha Falls, where it will rejoin the Chesapeake & Ohio. The road will be about 20 miles long.

A company has been organized for the purposeof building a road from Del Norte, Col., east thirty miles to Alamosa, to connect with the Denver & Rio Grande Railroad, forming an unbroken narrow-gauge connection with Pueblo and Denver. The work will be commenced immediately, and the road completed by the time the Denver & Rio Grande reaches Alamosa,

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MISCELLANEOUS.

There are 400 artesian wells in San Bernardino valley.

Pennsylvanians are boring for oil near Nashville, Tenn., and at 600 feet get a good "show."

The steamship Faraday, formaly used in laying cables, left New York recently with 152,000 bushels of wheat, the largest cargo of grain ever leaving that port.

An Iron mountain, 10,500 feet high, and rivaling the famous iron mountain of Missouri, has been discovered in Colfax county, New Mexico. The ore is almost entirely pure iron; immense quantities of coal are also found in Colfax county.

The Australian mail from Sidney, Sep. 21, by way of San Francisco and New York, reached London Nov. 2, making the remarkably quick time of 42 days against the run of 56 days made by the Peninsular and Oriental steamship line over the water route, via. Suez Canal.

The Mayor of Chicago, on the 30th ultimo, approved an ordinance to the effect that all buildings four or more stories in height shall be provided with one or more metallic fire-escapes in such location, number, etc., as the Mayor, Fire Marshall, Supt. of Buildings and the Chairman of committee shall determine.

The great oil-pipe line between Great Belt and Pittsburgh, thirty miles in length, is completed. The 28 refineries of the Standard Oil Co. in Pittsburgh will now receive their oil direct from the wells. The line was built by the American Transfer Co. and occupied 125 men six months.

The American export of petroleum has increased wonderfully within the last four years, until, to-day, there is scarcely a civilized spot on the face of the globe to which this cheapest of all illuminators is not shipped. The wells of Pennsylvania and West Virginia have yielded in all about 80,000,000 barrels, which has a value of nearly four hundred million dollars at the seaboard.

Capt. Brown, U. S. A., inspecting officer at the jetties, has officially notified the Secretary of War that on the 1st of December there was a practicable channel through the jetties, 21 3-10 feet deep at average flood tide; that the only interruption to a practicable channel of 22 feet was 90 feet in length, and that a line of sounding with 22 4-10 feet least depth extend through the bar to deep water.

By a recent decision of the Court of Appeals, affirming the decision of the lower court, declaring void the contract between the State and the Kentucky River Navigation Company, all the property and franchises of the company are restored to the State, and all barriers are now removed which kept the Lesislature from taking any action heretofore in regard to the much-needed improvement of the Kentucky river. An engineer will be appointed to make a careful survey of the river, and an estimate of the probable cost of repairing the locks and dams, to be presented at the next session of the legislature for prompt action.

Prof. Loomis has lately demonstrated the practicability of telegraphing without wires. His method consists of running a wire up to a certain altitude reaching a particular current of electricity, which, as he asserts, can be found at various heights. No matter what the distance, this same current can be reached by a similar wire, and communications can be had immediately. Professor Loomis has telegraphed to parties 11 miles distant by merely sending up a kite, at each end of the distance, a certain height, attached to which in place of the ordinary string was a fine copper wire. When both kites, though 11 miles distant from each other, touched the same current, communication was had between them both, and messages were sent from one end to the other by means of the ordinary Morse instrument in connection with the instrument invented by Prof. Loomis.

Since 1840 the entire exports of the Baldwin Locomotive Works have amounted to over six million dollars in value for finished engines, in addition to which repairs and detached parts for foreign countries amounted to over $200.000 more. The entire manufacture of locomotives for the period ending June 30, 1877, was four thousand one hundred and fifty in number, valued $52,405,106. The exports for the year ending November 1, 1877, amounted in value to $480,690.35. Thirty locomotives were sent to Brazil, five to Cuba, three to Canada, one to Austrailia: four steam motors to Cuba, and one steam motor to Russia, in addition to which parts of locomotives were sent to Russia, valued at $4,006.65; to Peru valued at $901.38, and to Mexico valued at $442. The tonnage of locomotives exported amounted to 3,521,215 pounds. The above exports of this one establishment for the year mentioned almost equal the entire exports of locomotives for the whole United States in 1876, which amounted to $461,559, the export of the Baldwin Works alone for 1877 being $480,690.35 as stated.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society, Associate of the Institution of Civil Engineers.

ADDENDA.—SPECIFICATIONS CONTINUED.

Continued from page 342.

All engineers are now aware that something more is necessary for constructive purposes than iron which will stand a high tensile strain. It has already been pointed out in the paper that a bridge constructed with hard brittle iron will, in all probability, stand the dead load test to all appearances with less signs of distress than a similar structure in the construction of which good tough iron has alone been employed. This is simply because the iron does not stretch, and, assuming the workmanship equally good in both cases, the bridge built with hard brittle iron will deflect less under the test load. It is advisable therefore when testing iron to enforce the specified elongation or contraction of area even with more firmness than the ultimate breaking strain. This view is to some extent endorsed by the following extracts from the report of Mr. Lavington E. Fletcher, Chief Engineer to the Manchester Steam Users' Association, on the Blackburn boiler explosion which took place in 1873:—

"Tensile strength however is not the only quality required in boiler plates, ductility is also necessary. This is too often lost sight of. A plate with a moderate tensile power, if ductile, is better for boiler purposes than with a high tensile strain, if short and brittle. To ascertain the ductility of the plates under consideration reference may be made to the reduction in area at the point of fracture given in the first of the preceding tables. It will be seen that this reduction in area varies considerably in different experiments. In the case of the test plates cut from the top of No 2 boiler, it is as low as 5.97, while the mean of the tests, cut from the top of that boiler is 7.29. This does not indicate a high ductile power. The same inequality will be seen in the rate of elongation, which in one case was 1.97 per cent., in another 7.60 per cent."

"The result of the investigation of the quality of the plates is, that though adequate in tensile power, they had not at all events some of them had not, that amount of ductility which it is desirable they should have seeing they were to be employed in the construction of a boiler to be worked at so high a pressure as 80 lbs. on the square inch. I do not consider however that the want of ductility was by itself the cause of the explosion."

The working strain to be put upon iron ought to be governed by the specified quality and tests, as well as by considerations affecting the purposes to which it is to be applied. When the moving load is relatively large to the dead weight of the structure, it will generally be found more judicious to employ an ordinary quality of iron with a small working strain, than to employ an exceptionally good material capable of sustaining a high working strain. Where good ordinary iron has been tested and found to be of a reliable character, it might be loaded with a dead weight to such an extent as to put a strain of six or seven tons per square inch upon it without danger; but in a small railway bridge of say 20 ft. span it is not safe to impose a greater strain than four or four and a-half tons per square inch upon the iron, on account of the varying and almost indeterminable effect of the rolling load. If a higher working strain is taken the rolling loads may cause the limit of elasticity of the iron to be exceeded, and however rarely this happens the structure must ultimately wear out. If an adequate rolling load be assumed, and a low strain be put upon the iron, good designing ought to render the wearing out of an iron structure in this way almost impossible, more especially as it would appear that the practical limit to the weight of locomotives has now been reached.

If girders are of the lattice type every care should be taken to provide for these heavy rolling loads by introducing counter bracing, or by so designing the diagonals that they may be capable of sustaining the maximum strains both of tension and compression. In modern bridges designed by our first engineers it is no unusual circumstance to find the strain allowed in the centre diagonals to be about two tons per square inch.

Sir William Fairbairn, at the request of the Board of Trade, carried out many experiments with the view of determining the effect of rolling loads. These will be found in his Third Series of "Useful Information for Engineers," and from these experiments the following particulars have been extracted, as they bear closely on the questions under consideration:—

A wrought iron riveted plate beam 20ft. clear span, 16in. deep, net effective area of bottom flange 1.775 square inches, gross area of top flange 4.3 square inches, web ⅜ of an inch thick, weight of girder 7 cwt. 3 qrs., calculated breaking weight in the centre 12 tons.

By suitable mechanism put in motion by a water wheel, loads were put upon and taken off this girder at the rate of about eight applications per minute without intermission either day or night.

With a load of 6,643 lbs., or about one-fourth of the ultimate breaking load, the calculated strain in the bottom flange was 6.25 tons per square inch of effective section, the deflection at the centre was 0.17 inches, which was not increased by 596,790 applications of the above load. At this point the load was increased to two-sevenths of the ultimate breaking load, so inducing a calculated strain of 7.39 tons per square inch of effective area in the bottom flange. The deflection was augmented to 0.22 inches, and after 403,210 applications, it was ascertained to be only 0.23 inches. As the beam had thus sustained one million changes of load without any apparent injury, the load was further increased to 10,486 lbs., or two fifths of the breaking weight. After 5,175 applications of this load the beam broke by tension a short distance from the middle, the calculated strain on the iron at that point being 9.88 tons per square inch of effective area.

The beam after being repaired was again subjected to 3,150,000 cappliations of a load equal to one-fourth of its breaking weight. This load producing no effect whatever it was increased to one-third of the breaking weight with which the beam failed by tension after 313,000 applications, the strain in the bottom flange being 8.45 tons per square inch of effective area.

From these results it would appear that the limit of elasticity of the iron of which this beam was constructed was about 8 tons. It required 313,000 applications of the load inducing a strain of 8.45 tons per square inch in the bottom flange to produce fracture, whilst with 403,210 applications of the load inducing a strain of 7.39 tons per square inch the girder sustained no injury whatever. It is well to notice that the beam was uninjured by nearly 4,000,000 applications of a load producing a strain of 6.25 tons per square inch in the bottom flange whilst it required only 5,175 applications of the load inducing a strain of 9.88 tons per square inch to produce fracture. There is every reason to infer from these results that the beam would have sustained an infinite number of applications of a load equivalent to one-fourth, or even approaching two-sevenths of its breaking weight.

The importance of these and analogous investigations are at once appreciated on an engineer being called upon to design new railway bridges, or to look after those already erected.

Mr. Benjamin Baker has conclusively proved, in his admirable little work on "Long Span Railway Bridges," that there are many circumstances, such as badly maintained permanent way, inclined cylinders, and unbalanced portions of the mechanism of locomotives, together with great weight and length of engines combined with short wheel base, which will at times render the effective load on one axle equivalent to 30 tons. This, taken with the deductions from Sir William Fairbairn's experiments, will almost render it necessary for an engineer to limit the life of railway bridge platforms constructed as of old with closely spaced shallow cross girders.

When a platform is first constructed every care is taken to have no two joints in longitudinal timbers on the same cross girders; unfortunately timber is a perishable material and railway work renewals are often left to the charge of navvies. They not being well versed in the art of bridge building sometimes make the longitudinal timbers to joint on the same cross girder, and in the case of a double line of way three out of the four may be found to do so. This is not all the navvies' fault; common sense, of which he has not a little, directs otherwise; but in order that traffic may not be interrupted, a short portion is commenced and finished at a time.

Assume a single line bridge with cross girders 3ft. 6in. apart originally designed to sustain 15 tons to each axle with a maximum strain on the iron of the bridge not exceeding 5 tons to the inch. Reasons have already been given why this load will at times be augmented to 30 tons and the longitudinal timbers be decayed and jointed on the same cross girder. It will not require more than 5 tons to each axle to produce the amount of deflection in the rails and timbers to correspond with that of the cross girder occasioned by the 25 remaining tons. But since a load of 15 tons to an axle induces a strain of 5 tons per square inch on the iron of the girders that produced by 25 tons will $= \frac{25 \times 5}{15} = 8.33$ tons. Fairbairn's beam failed with 313,000 applications of a load producing practically this strain per square inch; therefore if the bridge be situated on a portion of a line subjected to a traffic of sixty trains a day, going full speed, and the excessive load of 30 tons to one axle be only due once to each train, it will require but fourteen years to cause the destruction of the platform. The load of 30 tons may be due to either the leading, driving or trailing axles. The effect of the engine only need be considered, as the strain induced by the remaining rolling stock will be well within the limit of elasticity of the iron. The economy is thus made evident of keeping qualified men to look after a railway, who will see that everything is kept in a good working condition. Bad permanent way not only ruins the rolling stock and passengers' constitutions, but it greatly adds to the wearing out of the bridge platforms. With shallow cross girders oscillations are set up by heavy continuous traffic, which will soon shake loose rivets and bolts, and perhaps the connections with the main girders.

It may be remarked by some who never noticed a worn out bridge platform, that calculations of the foregoing nature, show ignorance of actual work, and that assumptions such as that each train may produce one excessive strain on a cross girder, may do very well for theory, but prove fallacious when subjected to the crucial test of practice. This may be so, for possibly the excessive load may occur more than once to each train, the constructive weakness referred to doing much to cause this effect. The author considers that the foregoing deductions point out some pitfalls to be avoided, and clearly show the effect of moving loads on girders and analogous constructions. Here is an actual example recorded in the before-mentioned "Long Span Railway Bridges," a book which all connected with railway work should read. The platform of the railway bridge over the Regent's Canal was constructed, owing to local circumstances, with cross girders only 8in. deep and 14ft. 6in. span. With a view of compensating as much as possible for want of depth, longitudinal stiffening girders 18in. deep were placed at a distance of 2ft. 3in. from the outer edge of each rail; each cross girder was also well secured by tee irons and gusset plates to the main girders. The bridge, notwithstanding that with 15 tons to one axle it was so designed that the iron should not be strained no more than 4 tons per square inch, completely gave away in four years. Mr. Baker attributes the failure to the employment of a 45-ton engine to work the traffic, the wheel base of which was 14ft.; the ends consequently overhung very much, which would greatly assist in producing oscillations and other undesirable consequences.

(*To be continued.*)

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*Paper read before the Liverpool Engineering Society, June 20, 1877.

THE Northern Pacific is graded west from the Missouri some distance up the Heart Valley. The road will be built twenty miles to the coal fields in the spring, and if the extension bill passes Congress it will be rapidly pushed to the Yellowstone at the mouth of Powder river.

THE JETTIES.

We have received from W. Milnor Roberts an article entitled, "The Jetty System and the Mouth of the Rhone," published in the Cincinnati *Commercial* of Nov. 23d, in reply to an article disparaging the 'jetty system," published in the same paper of Sept. 27, and copied by the Memphis *Avalanche* of Oct. 3. We regret that lack of space forbids its publication in full, and that we shall have to content our readers with a brief abstract sandwiched with such comments as may seem pertinent to the subject and to the present phase of the jetty question. As the article is evidently intended for a popular exposition, and as the arguments it contains have, for the most part, been published by us in one form and another, our readers will not so greatly feel the loss.

Col. Roberts, it will be remembered, was one of the mixed commission of seven sent to Europe in 1874 to examine and report on the "jetty system" as there developed, and subsequently one of a commission of seven appointed to examine the jetty works in progress at South Pass, in the fall of 1875. He has always been an enthusiastic and consistent supporter of the jetties, exercising toward them the functions of a god-father. His writings have persuaded more engineers of their ultimate success by far than the intimidating arguments of Mr. Eads. At the present time they have a peculiar value in that popular newspaper agitation preliminary to the second payment.

During the past year and a half we have published much in regard to the jetties, and we think our opinions are sufficiently well known to our readers without extensive review. Suffice it to say that the progress of the work thus far has tended to confirm rather than to change them.

Col. Roberts, after referring at some length to the investigations of the commission at the mouth of the Rhone, and also to Gen. Humphreys' report for 1875, says:—

"Probably General Humphreys was not aware that these dykes had never been extended through the bar to deep water, and that therefore the jetty system, as now understood and put into practice at the mouth of the Mississippi river by Capt. Eads, had really never been tried at the mouth of the Rhone. I am quite sure that this fact was a matter of surprise to every one of the six members of the Commission referred to, who visited and examined the works in 1874 including the three United States Military Engineers, Generals Wright, Alexander and Comstock."

Passing by the charge of ignorance which, we think, shows an entire misapprehension of Gen. Humphreys' idea, though evidently unintentional, we freely admit that the "jetty system," as the term is used, has never been applied to the mouth of the Rhone. We have no objection to the Rhone argument as used by the jetty advocates, although we think it has been re-vamped sufficiently, did not their language adroitly imply intentionally or otherwise, that the "jetty system," if used there, would have succeeded.

It would seem as if the closure of all lateral outlets and the confining of the waters to one channel by a dyke would present conditions exceedingly favorable to the success of jetties. The reasons for their abandonment, and the substitution of a lateral canal, we do not recollect as being given by any of the advocates of the "jetty system." Those reasons are given very succinctly in the paper* of Maj. Stokes, R. E., the English representative on the Commission for the improvement of the mouth of the Danube, and, we think, are sufficient.

The questions as to the Rhone may be put thus:—

1. Was the jetty system there applied?

2. If it had been there applied would it have succeeded?

We would answer both in the negative. However, in the absence of its application to the mouth of the Rhone, all the arguments deduced from this example are mere negatives, and as such without value and should be relegated to our mental garrets.

"At the Sulina mouth of the Danube, which the same Commission carefully examined in 1874 which is fairly analogous to the South Pass of the Mississippi, the jetty system had been faithfully tested, and was complete, and perfectly successful."

Then follows a description of the works and their results; arguments as to the necessity of carrying jetty work across the bar; results at South Pass, and the Commission of 1875 of which Sir Chas. A. Hartley Engineer of the Danube jetties, was a member. We cite the following opinions which as opinions, are entitled to great consideration:

"After a thorough examination of every part of the works, and of the position and characteristics of all the mouths of the Mississippi, Sir Charles Hartley remarked that the circumstances at the South Pass were decidedly more favorable for obtaining a deep channel by means of jetties than they were at the Sulina mouth of the Danube. This was also my own opinion, formed in the fall of 1874, after returning from our examination of both places. That opinion rested and rests mainly upon the fact that the slope of the bottom in the gulf outside of the South Pass is about three times as great as that at the Sulina mouth of the Danube."

And again,

"There is a radical difference between the Lower Danube and the Lower Mississippi, in an important particular. It is this: In the case of the Danube, while the jetties have created a channel depth through the bar of twenty-one feet, the river itself above, even where it has been "*trained*," has only eighteen feet depth; while in the Mississippi, above the head of the passes, it is one hundred feet or more in depth, and so continues for more than a hundred miles."

The deduction that "the natural conditions of the lower Mississippi are remarkably favorable for a deep entrance between the main river and gulf," naturally follows. The remainder of the article is devoted to controverting the opinions and facts of the *Avalanche* and *Commercial*, the point of chief present interest being that the commission inserted in their estimates "about $250,000 as the assumed cost of dredging." The whole ends with the usual peroration as to the wonderful results accomplished.

Mr. Roberts' article is exceedingly good, and as a jetty advocate his arguments are very able. We do not propose to busy ourselves in controverting them at this late day. We can well afford to save the racking of our brains until either success or failure is attained, and then have a grand mental tournament to decide whose original views, if any one's, have been corroborated. The point which we wish to impress is that European works have been and are persistantly cited as precedents for the South Pass improvement, the Sulina mouth of the Danube being especially urged as bearing a close analogy to South Pass. We fail to see more than a geographical resemblance in surface features. Both rivers have three outlets, similarly situated and each discharging very nearly in the same relative proportions. The Kiliah or Northern branch has nearly the same relative volume to the whole volume of the Danube as the North East Pass has to the volume of the Mississippi, and like it, discharging in the face of prevailing winds its mouth is broken up into numerous outlets. The St. George or Southern branch resembles South West Pass in position, freedom from obstruction and relative discharge. The Sulina resembles South Pass in being the shortest of the three occupying the same relative position and having the same relative discharge Further than this the analogy does not apply. The Danube delta is stable, its shore line has long since ceased to advance, the bed of the passes is comparatively stable and their regimen permanent. A heavy store house has been built near the foot of the jetties, and the material employed for the construction of the jetties was pile work and stone. None of these conditions apply to the Mississippi delta. A storehouse of any magnitude could not be built below the head of the passes unless floated on a raft, and stonework used as at Sulina could not be resurrected until the next geologic upheaval. The Sulina mouth is not at the head of the passes but leaves the St. George branch some distance down and is moreover some fifty miles in length, and has also three feet fall at low water. It discharges 2-27 of the volume of the river, relatively about the same as South Pass. But the volume of South Pass is nearly equal to the whole volume of the Danube or a dozen times greater than that of the Sulina branch. It is only 12 miles long, and the surface slope at low water may be considered nothing. All the waters that enter the head of Sulina are by necessity compelled to flow out through the jetties, and do the work of excavating and maintaining the channel. But at South Pass the set back turned a large quantity of water into the other passes causing their enlargement. Such could hardly take place at Sulina. These distinctions can be carried much further. All the analogies existing are on the surface and of no use except as specimens for our cranial curiosity shop. John Smith may be an angel, and yet have a close resemblance in features to the fiend, Hank Brown.

We pointed out nearly a year and a half ago that the great danger to be apprehended at the South Pass was that the damming action of the works there constructed would cause a permanent diminution in cross-section, the other passes at the same time increasing in size, and that the existing equilibrium once destroyed, the ultimate result must be the conversion of South Pass into a bayou. This opinion was confirmed much sooner than we anticipated, and permanent works at great expense were last spring constructed at the head of the passes to permanently control the flow into South Pass. We did not then think that these works could more than temporarily accomplish the results for which they were designed. Should they prove efficient the jetty project may meet with success, although of late we confess that the freaky action of the current within the jetties themselves has somewhat disturbed our hopes.

As to its natural conditions the mouth of the Mississippi is eminently *sui generis*, and all plans for its improvement must be based on a complete and exhaustive study of its local peculiarities; foreign precedents, and surface analogies so often and liberally quoted should be sparingly used. We regret that this has not been the case; at least it has not appeared in the reasoning presented for popular digestion. It may, however, exist in a latent and to be discovered form.

In conclusion we cannot do better than to quote the following "axioms" from Major Stokes' paper previously referred to:—

1. That the mouth of every river has its own local peculiarities on which the successful treatment of it must depend.

2. That in studying to apply general principles to the improvement of any river, its local conditions must alone be allowed to guide such application.

3. That the fact of works having proved successful, or having failed at any river mouth, by no means ensures that the same kind of works will succeed at any other river mouth, unless the very same conditions exist.

*See ENGINEERING NEWS, May 26, June 2, and June 9 1877.

THE *Evening Wisconsin* is complaining about the filthy, slimy wooden pavements of Milwaukee. We judge it to be part of the design, but without further enlightment we fail to see the utility of an inch and a half of disgusting dirt on the top of a wooden pavement.

THE Commission on the Chicago Post Office and Custom House has decided that the east entrance, on Dearborn street, is the main front of the building, and that entrances should also be made at the other three points of the compass. Let another Commission be appointed to make additional entrances at the four angles, and erect over each a pagoda tower.

FORMALITIES are being completed for the construction of a maratime canal from Havre, touching at Harfleur and joining the Seine at Taucarville, sixty miles below Rouen, thus avoiding the dangerous navigation of the lower Seine. The canal will have a width of 25 metres and a depth of 3.5 metres, the Seine being also improved to the same depth up to Paris. The entire cost of the improvement is estimated at 21,000,000 francs.

APROPOS of the Tennessee River Convention at Chattanooga, the Nashville people are waking up to the desirability of improving the Cumberland, which they represent can be done at far less expense. No canal would be necessary, and only a few locks and dams to give navigation the year round to Mill Spring, Ky. The fine farming country and the coal and manufacturing interests to be developed, are urged with much vigor by the Nashville papers.

THE telephone is to be adapted to conveying signals in mines, and in that capacity will, no doubt, prove very useful. It was recently tried at Cincinnati as an aid to submarine divers, and with slight modifications will be very successful. A greater improvement over the old rope signal can hardly be conceived. It has been used successfully on the water pipe of the Rochester water supply from Hemlock Lake to Rush reservoir, a distance of thirty miles, the wire being switched out entirely. It was tried in Chicago on the 12th inst. through an uninsulated wire laid on the railway ties, and worked admirably. Experiments are now being made with an

uninsulated wire laid in the lake with promise of success. Let some one try it between a couple of balloons with no connection at all. Take a hint from Professor Loomis' experiment.

THE new iron bridge over Ashtabula Creek, Ohio, was tested on the 8th inst., in the presence of Mr. Gottlieb, of the Keystone Bridge Co.; L. H. Clarke, Chief Engineer of the L. S. & M. S. R. R., and various railway officials. Six engines were employed in the test, which was very severe. Great care was taken in noting the motion of the bridge under the tests, and as a result it was pronounced safe in every particular. Cost, about $30,000,

ON the 6th inst. a bill was introduced in the House to direct the Secretary of War to appoint four commissions, each to consist of two government engineers, one civil engineer and two river men, to consider and mature plans for the improvement of the Mississippi and its two tributaries the Ohio and Missouri. One commission is to confine its works to the Mississippi below the mouth of the Missouri, another to the Upper Mississippi from the Missouri to the falls of St. Anthony, another to the Missouri from its mouth to Fort Benton, and the fourth to the Ohio from its mouth to Pittsburgh.

THE treaty between this country and Nicaragua on the subject of the Nicaragua Inter-Oceanic Canal was not sent to the Senate by Mr. Fish because of some objections made to one of its provisions by the representative of Nicaragua. Great interest is taken in the subject by the Secretary of State and a new treaty will, no doubt, be submitted to the Senate at this session. Meantime it is stated that European capitalists are trying to secure the exclusive privilege from the government of Nicaragua of constructing this canal, and with some prospect of success.

A GOOD example of judicious expenditure of public money is furnished in the harbor of Wilmington, the port of Los Angelos, Cal. The government has expended $425,000 on a breakwater and in dredging, and now there is a depth of 9 feet at low tide, or 15 feet at high tide, over a bar where formerly there was a depth at low tide of only 1½ feet. The depth to be ultimately attained by the works in progress and projected is estimated by the engineers at 17 to 19 feet at low tide or 23 to 25 feet at high tide. Inside the bar is a sheltered ship channel of several miles in length, 600 to 800 feet width, and a low tide depth of 25 feet. This harbor is of great importance to the Pacific coast, not only on account of its commercial importance, present and prospective, but also from the fact that it is the only harbor of refuge between San Diego and San Francisco, nearly 500 miles.

WE have been watching the progress of the new Court House in this city, and we take pleasure in saying that the quality of the stonework excites our unqualified admiration. How it will stand age we do not know, but we hardly enticipated so good work under the authority of the old board. The basement and first stories are up, and the brickwork is covered in for the winter. Not as a building expert, but as a citizen, we would like to ask the architect if it is customary to level up iron floor-beams with stray blocks of wood? We simply desire enlightenment.

The miserable, rotten, patched, petroleum-spotted, iron-blotched, scaled, disintegrated and decomposing Cincinnati sandstone of the Chicago Custom House is not to be compared to the Lemont stone of the Court House, and yet it cost as much as granite. Dentals have utterly disintegrated and fallen off, the roof stones of the porticos are black and as patched as a tramp's breeches, and a whole portico has been taken down already and re-cut. A generation from now it will do to put under a glass case and take the prize over the moss-grown, dilapidated ruins of "merry England." We have seen it intimated that the results, on the completion of the stonework, have disproven the report of the first commission on the foundation. It must not be forgotten, however, that material alterations have been made which have greatly reduced the weight on the foundations, and that piers and footings have been tinkered to distribute it more uniformly. The Chicago Custom House, as a whole, presents more evidence of incompetence and corruption than it has ever been our lot to witness in a single structure. Yet some will agree that black is white.

INFORMATION wanted of the manner in which Water Boards or companies are authorized by law to be formed in each state in the Union. Some States have general laws on the subject, some require special enactments for each case, and others seem to have no fixed rule at all. We wish to obtain the above information *at once*, and we are certain that some of our subscribers in each State will be kind enough to look it up for us without delay so that we can use it at as early a day as possible.

THE *Cincinnati Enquirer* of the 5th inst. contains the form of permanent lease and contract for the completion and operation of the Southern railway. It filled two columns of finely printed matter, and is cut up into numerous digestible pieces by the terms *whereas, sec., art.* and *note*. It is proposed to advertise the plan in Cincinnati and the East and West for bidders, who are expected to take and complete the road under the terms and specifications previously referred to. The length of term and kind of rent is left open for consideration. The lessees are to complete the road, supply the rolling stock, make repairs, pay taxes, to pay money to keep up the organization of the trustees, and to provide trustees with passes and an inspection car, etc., to provide terminal facilities at Cincinnati and Chattanooga, etc. Several legal clauses in regard to perfection, arbitration, power of attorney, successors and assigns, follow *ad infinitum*,

A SURVEY of the jetty channel made at Port Eads, La., December 6, shows twenty-two feet of water in the channel, with a maximum width of one hundred and twenty feet through to deep water. Everything indicates that Congress will ere long be asked for the second payment of $500,000. The dredge boat, "Bayley" is doing good work. Some may be captious enough to say that the original arguments of Mr. Eads did not contemplate anything resembling a dredge boat within a day's journey of the Pass. Be that as it may, there can be no doubt that they were contemplated by the commission, and we think it would have been the part of wisdom to have filled the Pass with dredges from the beginning, both at the head and at the jetties.

We were creditably informed last May that about a million and a quarter of jetty stock had been issued though we were not informed as to what portion was paid up and where and how held. At that time we were also informed by one well posted, and eminently friendly to the jetties, that the works at South Pass had cost in actual expenditure not over $750,000. Of this, $500,000 has been repaid in the January payment. How much has been expended since we do not know, but if our figures are correct the next payment of $500,000, and the subsequent payment of $250,000 to be made after the channel of 22ft. is maintained for one year, would more than repay the actual outlay on the works.

We are heartily in sympathy with the next payment, and have no doubt it will soon be made. It is true that after the January payment on the 20ft. channel of 200ft width, said channel did not exist except at short intervals for several months thereafter; and it is entirely possible that after the payment for the 22 feet channel is made, that channel, owing to low water, may not exist until the spring floods. But let the payment be made for the sake of peace if nothing more. We hope no influence will be brought to bear to jeopardize the success of an experiment worth more to the profession, as an experiment alone, than it will ever cost, and in the event of success of untold benefit to the country at large. Should it fail from the inadequacy of the works at the head of the passses, from local action in the pass and jetties, from the enlargement of Cubitt's Gap, from a half dozen causes combined,—in the several years which it will take to demonstrate beyond cavil the result, a commerce will have sprung up in the Mississippi Valley which will quickly push forward and construct an adequate substitute.

Liverpool, England, has decided upon getting water from Wales at a cost of $6,250,000.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 80th regular meeting of the Club was held at the Sherman House on Tuesday, Dec. 4, 1877, beginning at 4 P. M. The minutes of the November meeting were read and approved.

The Secretary reported a donation from Gen. A. A. Humphreys, of Vol. IV. of "Report on Geological Surveys West of the 100th Meridian."

The following named gentlemen were elected members: C. W. Laing and W. H. Hedges, Chicago; T. C. Bradley, Evanston, and Ch. H. Tutton, Eau Claire, Mich.

The President submitted the names of W. F. Kay, J. Frank Aldrich and A. Gottlieb, of Chicago, R. Ralston Jones, of Keokuk, and J. S. Sewell, of St. Paul, as candidates for membership.

The President make some remarks on Mr. Hay's new method of making iron, and exhibited a specimen of the iron which had been tested with very satisfactory results.

Photographs were also exhibited of the pumps, designed by Mr. F. W. Clarke, just constructed for the South Chicago Drainago Works.

Mr. L. M. Johnson read the paper for the evening, No. 72, on "Maintenance of Way," which was discussed at some length.

A resolution was passed directing the Secretary to address a circular to each resident member asking what hour he considered best for the Club meetings. It was voted that the January meeting should be held on the first Wednesday instead of the first Tuesday of the month.

The committee on Papers announced that two papers would be presented at the next meeting, one by Mr. W. S. Pope, and one by Mr. E. A. Fox.

The meeting adjourned.

L. P. MOREHOUSE, *Sec.*

LIVERPOOL ENGINEERING SOCIETY.

On Wednesday evening the 21st inst. the Society held its usual fortnightly meeting in the rooms of the Royal Institution, Colquitt street, Mr. C. Graham Smith, A. I. C. E., President, in the Chair. In continuation of the discussion on Mr. Brodies paper on road making, Mr. John Birth said that in the iron districts slag was largely employed for road making, and mentioned that a firm had informed him that they were turning out 1,600 tons of broken slag per month for road making. A paper on graving docks was read by Mr. Wilkinson Squire. One of the principal points to be attended to in designing the cross section of a graving dock is to so construct it that there may be plenty of ventilation so that ships may "dry" as quickly as possible. He pointed out that it is necessary for graving docks to be of such a size as regards length, breadth of entrance, and depth of sill as to accommodate the largest ships trading to the port. As the ships always discharge their cargoes before entering a dry dock the sills may beat least six feet above that of the wet dock from which they enter. As the largest ocean steamers do not exceed 500 feet in length and 45 feet beam, a length of 500 feet and a clear width of entrance 960 feet has been found sufficient for a moderately sized dock, but at Birkenhead and Liverpool the graving docks are as much as 900 feet in length. By means of a diagram the manner of constructing altar courses, and the various other details of construction were clearly shown. The author's elements on foundations and the methods of dealing with springs were particularly valuable, as also were his statements concerning the advisability of taking every precaution to cut off the outside water from the foundations. The author touched upon the hydraulic and other necessary machinery for working ships in and out drying and graving docks, and considered in detail the various materials employed in their construction.

A MINING TUNNEL THIRTY-ONE MILES LONG.

After thirty-three years of uninterrupted labor the great undertaking of the Rothschonberger water adit is so far completed as to admit of its use. The method of draining the Freiberg mines, Saxony, by means of a deep tunnel, had already been discussed in the beginning of the present century, as a question

of necessity for the future mining prosperity of the vicinity; and undoubtedly the Rothschonberger tunnel is the greatest work of the kind that has ever been undertaken to aid the exploration of a mining district. Other great adits, such as those of the Hartz mountains and the famous Sutro tunnel, fade when compared with a tunnel which has already attained a length of more than 26 English miles, and will be with its branches, when completed, more than 31½ miles. The plan was to conduct the water from the Freiberg mines to the nearest practicable point on the River Elbe. Rothschenberger, 12 kilometers above Meissen, was chosen as the most advantageous place for the mouth, on account of its having the lowest level at the shortest distance from Freiberg. The preliminary surveys were made in 1843, but the work was not thoroughly taken in hand until the third quarter of the year 1844. Since that time the driving of the tunnel has been unceasingly carried forward, but coupled with many hindrances and difficulties, such as quicksands, immense quantities of water, etc., which have trebled the cost and retarded its completion.

The tunnel is ventilated by eight air shafts, and lies some 400 feet below the deepest Freiberger water adit. It has a uniform height of 9.84 feet with a somewhat smaller breadth. The present length of the adit with its ramifications is 43,000 meters (all of which length is now in use), and will be when completed over 51,000 meters, or 31½ miles. The cost of the tunnel is estimated at 12,000,000 marks or $4,000,000, and will be paid for by a tax on all the mines which it directly benefits. The gradient of the floor is only 0.03m. in 100 meters. This small gradient may make it necessary to clear the tunnel occasionally, but this can be accomplished without difficulty with suitable boats and dredges. Five miles of this tunnel are perfectly straight, without the slightest curve, and along the whole length the curves are very light. One rather interesting occurence during the past year was the striking of an old mine, of which no maps are in existence. The mine is probably more than four centuries old, and the timber which had been used as supports, etc., was found for the most part sound. Two new veins were also struck, but only one of them will be exploited. It is rather remarkable that nearly the whole driving of the tunnel has been done by hand, Burleigh drills, driven by compressed air, having been introduced within the past year. The rock throughout nearly the en ire length is solid gneiss, which accounts for the great time that has been taken to the work, it being necessary, with hand boring, to put in as many as from 40 to 50 holes to the face.

The necessity for the continued prosperity of the Freiberg mines, which have now been worked for about seven centuries, may be gathered from the fact that at the present time there are more than 6000 laborers, with their families, amounting altogether to some 20,000 persons, who derive sustenance from the mines and metallurgical works connected with them. It may reasonably be expected that the Rothschonberger tunnel will give fresh impetus to the Freiberg mining, and consider ably augment the output of ore, which has of late years somewhat fallen off, owing to the immense quantities of water which continued to flood the mines, and prevented the veins of ore being followed and worked below a certain depth.

Saxony may well and justly be proud of a tunnel which is without doubt the longest in the world, and which has required so much time, perseverence, skill and labor as the Rothschonberger water adit.

PALACE CARS.

The palace car is a characteristic product of our national life. Without the traditional ties that bind the European to his hereditary home, with the general belief that change is not to be dreaded either in home or calling, the whole nation is ever in restless motion. The shrewd, industrious, intellectual Yankee farmer of New England is fast disappearing, ill replaced by coarse-fibred imported Hibernian material; the American pioneer blood which brought into rough subjection the fertile West is almost gone, replaced—and here well replaced—by the heavier German stock; and similar movements are going on in Pennsylvania and, on a smaller scale, in other parts of the Union. In fact, a large part of our people is ever turning over in its head the advantages of somewhere else. Besides this, business in a large part of the country is mainly transacted through "travelling men," who are constantly on the road. The palace car is a natural result of all this. It bears some softened traces of the Mississippi steamboat style, which was our first national attempt at democratic splendor. It has its peculiar school of manners, and not a bad one, whose principal feature is the duty of being always ready to chat with your male fellow-travellers.

As a steady place of abode it has many faults, but on the whole it is far more comfortable, in the poorer portion of the country at least, than the average small hotel, or indeed than the home of most of its occupants. The attentive colored servant, and, above all, the cookery of the dining-car, are scarcely found elsewhere in many States. We have been in a town of over a thousand inhabitants where no book or New York paper could be bought except at the cars, and in "cities" where there were no toilet accommodations to compare with them. In localities where half an hour or more is usually spent in slowly frying the thin beefsteak or boiling the muddy coffee, the palace cook is a missionary of health and joy. These advantages, and the great saving of time by night travel, are well recognized, and every year the number of these cars increases; so that their management is a matter of national importance. We notice this year one or two improvements, and especially this: that the dining-cars—almost the only places where one can get a well-cooked meal beyond the Mississippi, or, indeed, a tolerable cup of coffee—have come into use on nearly every through-line. The Pittsburgh & Fort Wayne road is almost the only great road where we have lately been aroused to breakfast before daylight and dinner before noon; but the Eastern roads are in this, as in many other points, still inferior to the Western ones. Another convenience that has come in at the West is that the porter, before reaching the end of a road, takes orders for palace cars beyond, and telegraphs them without trouble or expense to the traveller.

There are still many points, however, in which these cars are imperfect, and it is to some of these that we wish to call attention. Their primary use is for sleeping, yet most persons find their first night or two in them painfully wakeful, and look on their title—"sleepers"—as a whimsical stroke of American irony. The lower berths are much the most convenient; yet, unless the traveler goes to the unusual expense of buying a whole section, he is probably waked in two or three hours by their closeness. This could be easily remedied by a light rod on the edge of each berth, holding the curtains off a couple of inches from it, so as to allow a slight upward draught. We have found by experience that this kept the air tolerable, and it could be introduced with very little expense. There is also a frequent carelessness in providing buttons to secure the curtains and protect the privacy of the sleeper, which can be readily remedied. The upper berths are better ventilated, but the gap is so wide above the curtain that they are full of glare and noisy with snores. This, again, could be easily cured by carrying the curtains to within three inches of the roof. Another trouble is that travellers are driven by the dreary darkness of the car in the early evening to go to bed before their usual hour, and, indeed, directly after supper, and so the difficulty of sleeping is increased. There are usually but three high-hung candles for the main room, with perhaps a score or more of persons in it. This is quite unnecessary. There should be a chandelier or bracket with several candles ready to insert just overhead in each section, so that reading or playing cards could be made possible. The old evil-smelling oil-lamp, with its glaring reflector, has, fortunately, been abolished in all but a few ill-cared-for old Pullmans; but something is needed in its place, and the above arrangement would be simple and convenient. After travellers have gone to bed there should be no lights except those at the ends of the car, for the present way of leaving the middle ones lighted is very disagreeable in the upper berths. Another point is that there should be less heat in the night. The porters too often make up large fires, to last all night, and go to bed untroubled by the night-mare of the guests. They should have thermometers and be forced to keep the temperature in the vicinity of 50°. This would not remedy the whole trouble, for the ventilation openings are too small, but with higher curtains no objection would be made to their being all wide open. This ventilation annoyance is one of the most serious difficulties of the palace-car at all times. In summer the drawing-room car is frequently hotter and closer than the common car, and many avoid it on that account. The openings in the monitor roof are quite too small. The large windows of some of the best drawing-room cars, for some inexplicable reason, only open a few inches, and are frequently not screened from entering cinders; and they are provokingly adjusted, so that when open they have their wide lower bar just against the pleasantest part of the view, and the cindery air-current blows right in your eyes. This trouble in ventilation should be considered in the construction of new cars; and so should some more efficient system of springs, for the palace-cars are frequently no better hung now than the ordinary cars on the road, and the jar is the cause of a great part of the fatigue. The chairs are, of course, the principal feature in the drawing-room car, and their construction is all-important to comfort, but we never sit down in one without asking ourselves whether the persons who order them have any definite ideas about comfort, or are not, like the brakeman, too young, active, and unused to sitting down, to care anything about chairs. Most of the chairs of recent date are too small in the seats for any journey of over two hours; they are fatally defective, too, in having no support for the head, the neck being the part of the person which grows weariest in prolonged sitting, and which is most difficult to provide for in attempting to take a nap. Whatever railroad managers may think, a nap is, however objectionable in church, a perfectly innocent, and indeed laudable, indulgence in a car. The contortions which unfortunate passengers, and especially invalids, have now to undergo in order to get into a sleeping posture are discreditable to both Wagner and Pullman and their families. The back ought to be six inches higher, and the difficulty about cleanliness is readily met by a small linen cover, which, however, it may be proper to add, should be washed before each trip. The upholstering of the chair also seems to be the conception of a thoughtless young brakeman. Spring-bottomed chairs should never be used in a public vehicle, because the usage they get is too hard, and repairs too expensive. They are very comfortable when new and in good order, but they are so incessantly flopped into by persons of both sexes who weigh two hundred pounds and upwards, that the springs are soon weakened, and the seat becomes a kind of round trough, in which you are jammed down, with a hard wooden bar passing under your legs just above the knee, impeding circulation and benumbing the great sciatic nerve. The springs should be all torn out, and replaced by a good clean and cool cane bottom, or else a wooden one with a hair cushion, which can be made over at small cost whenever it gets hard. But all these things ought to be looked after not by a mechanical engineer or a prominent financier, but by some one who gives *thought* to personal comfort, which apparently but few persons connected with railroads have ever done. The arrangement for disposing of one's clothing, for instance, in the sleeping-car are evidently devised by brakemen, as they consist of one hook for each person, so high up as to be only accessible, without considerable difficulty and danger, to a practised gymnast under forty-five. There ought to be a rail or small shelf for this purpose let down in each berth, which also would increase the security against theft. Some Scriptural texts and sayings of philosophers, directed against the practice of loud talking and snoring in the car during sleeping hours, ought to be inscribed on the glass of the lamps or other conspicuous place.

As a general thing there is no trouble to be found with the porter, except in the overwarm fire at night, and we have fancied that more carefully watched lately. He will earn his small fee. Perhaps in time the etiquette of the train-peddler may be less rigorous, and he may not be so unfailing in his interruptions, or so certain in his rebuke of persons who are not willing to have his weekly papers thrust on them. But this is anticipating too much, probably. One thing might be more extensively introduced on trains which, like some of the northerly trains from Boston, carry passengers in the excursion season for five or six hours without a break, and that is an arrangement by which the porter could

upply passengers with ices or a light lunch in their seats without any bother, as is now done between Philadelphia and New York, and between Philadelphia and Washington, if we remember rightly. Every year we travel more, and to many these little details of good ventilation and food and seating mean great increase of comfort and strength. Let us hope that improvement will go steadily on.—*The Nation.*

THE STATE SURVEY OF NEW YORK.

We make the following extracts from an Albany paper:

The State Survey party, under the immediate direction of James T. Gardner, who is director-in-chief of the work, is making excellent progress. Within the last few weeks the entire northern line of Albany county has been marked by granite monuments, at an average distance of three miles apart. During the season which will soon close, the lines of ten counties have been accurately determined and wholly or in part marked by monuments of the most permanent character. They are Albany, Rensselaer, Saratoga, Schenectady, Schoharie, Otsego, Montgomery, Fulton, Herkimer and Oneida. The aggregate length of the county lines marked is about 175 miles. The lines of Delaware county have also been determined, but no monuments set. The monuments are set into the ground about four feet, and project from two to four inches above the surface. Upon the top of the stone grooves, a quarter of an inch deep, are cut, crossing each other at right angles, the intersection of which indicates the point marked by the monument. Upon the sides are cut "N. Y. S. S." and "C. B." (New York State Survey, County Boundary) and a number, so that a person dropped from the clouds, if possessed of certain data, could ascertain, by an inspection of the marks, his latitude and longitude within two inches. To prevent the loss of the point by the removal of the stone in any manner, it is also marked by a stoneware crock, with a hole in the centre of the bottom, buried in the earth at a depth of five feet, or where a rock is found, by a copper bolt in the rock. If the original bolt should be disturbed, the point could be determined approximately by reference to the other, and then on digging, the discovery of the crock or bolt would again settle it accurately.

REPORT ON WATER RATES.

BY D. FARRAND HENRY,

Chief Engineer Detroit Water Works.

To a special committee of inquiry of the Detroit Common Council, D. Farrand Henry, Chief Engineer of the Water Works, recently submitted the following report, which will be found of general interest as giving the rates paid for water in many of out principal cities:

I herewith submit a tabulated statement of the water rates in thirty-eight cities. The basis of these assessments so varies that it is very difficult to make any comparison, but any one can by these tables find what his own assessment would be at any of the different rates. I have, however, as an example, calculated the assessment of a first-class house, having all the water fixtures, by the rates lately received from a dozen different cities, as shown in the table given below. Of these cities ten are much higher than Detroit, while only Hartford and Cleveland are lower.

But the present assessment in this city pays in addition to maintenance, interest, etc., for the necessary extension of the pipeage, while in some, as Philadelphia and Milwaukee, lots in front of which pipes are laid are charged from 80 cts. to $1 per foot front, and in others, as Cleveland, Hartford and Buffalo, the extension of the pipeage is paid for in the general tax.

In an additional table I have given the rate per 100 gallons at which water is sold in the several cities. Thus, as we have seen, the assessed rates are here lower in most instances than in other cities while the water rates for manufactories and other purposes are as low as they are anywhere.

In fact, if we take into account the amount of water distributed per capita, which is greater here than almost anywhere, the citizens of Detroit actually pay much less for the water consumed than those of any other city. I have no doubt that if the enormous waste of water could be checked, the assessments might be reduced materially below even their present comparatively low grade. But if the citizens will not second the efforts of the Board to prevent waste, but will persist in their lavish use of water, there seems to be no just ground of complaint of the present price thereof.

The following is the table referred to as showing the price of water per year for a family of five persons in a first-class dwelling in the cities named:

Hartford	$23 00	Chicago	$34 00
Philadelphia	27 75	Milwaukee	34 50
Brooklyn	29 25	Toledo	28 25
Albany	31 00	Louisville	31 50
Buffalo	43 50	Pittsburgh	71 59
Cleveland	27 50	Detroit	23 50
Cincinnati	33 80		

The following table shows the price charged per 100 gallons in the cities named:

Cities.	*Price, cts.*	*Cities.*	*Price, cts.*
Charlestown, Mass, from	2 @3	Cleveland	1 @1⅔
Salem, Mass.	2 @3	Cincinnati	1½
Concord	1½@2½	Bay City	1½@4
Providence	3	Chicago	1
Hartford	1 @3	Evansville	1½@2
Philadelphia	1⅔	Indianapolis	2 @4
Albany	1 @4	Milwaukee	2
Brooklyn	2	Memphis	1½@2
Jersey City	1¼@1½	Kansas City	2 @5½
Oswego	1 @4	Toledo	1½@2
Syracuse	1 @4	Columbus	2
Rochester	2 @4	Louisville	1½@3½
Buffalo	2 @3	Detroit	2

THE RAILROADS OF ILLINOIS.

The Springfield *Journal* gives from the forthcoming report of the railroad and warehouse commissioners of this State, now in press, some interesting figures concerning Illinois railroads which we give as follows:

AMOUNT OF TRACK.

Main line—entire length in miles	11,097
Double track	622
Length in Illinois	5,267
Branches—entire length	4,075
Length in Illinois	2,093
Total length main line and branches in Illinois	7,365

BRIDGES, ETC.

Number of wooden bridges in Illinois	1,222
Length of wooden bridges in Illinois in feet	121 437
Number of stone bridges in Illinois	54
Length of stone bridges in Illinois in feet	1,070
Number of combination and iron bridges	164
Length of combination and iron bridges	36,663
Number of wooden trestles	4 240
Length of wooden trestles	386,747

EQUIPMENT.

Number engines	3,318
Number passenger cars	1,440
Number express, mail and baggage cars	608
Number box and stock cars	43,076
Number coal and flat cars	20,062
Total	65,283
Number stations in Illinois	1,553
Number of junctions in Illinois	334

STOCK AND DEBT.

Preferred stock	$59,414,767.56
Common stock	251,375,523.07
Bonded debt	268,164,230.42
Floating debt	6,793,309.71
Total stock and debt	561,391,411.22
Stock and debt per mile	38,736.75

GROSS RECEIPTS—ENTIRE LINE.

Passengers	$ 24,942,718.83
Freight	64,788,925.31
Mail, express, etc	5,553,931.48
Total	$96,042,019.45
Average gross receipts per mile	4,313.81

ACCIDENTS AND DAMAGES.

Passengers killed	10
Passengers wounded	42
Employés killed	65
Employés wounded	212
All others killed	132
All others injured	103
Damages paid persons killed or injured	$ 3,538.00
Damage paid for stock killed	105,017.41
Damage paid for property destroyed by fire from engines	30,794.45

EXPENSES AND RECEIPTS — ENTIRE LINE.

Ordinary operating expenses	$61,885,651.50
Average expense per mile	2,920.50
Extra expense, as tax, etc	2,799,950.93
Total operating and general expense	64,505,748.56
Excess of receipts over expense	31,317,349.59
Deficits	247,756.42
Average net receipts per mile	1,485.71
Paid for new buildings, equipments, right of way, etc	3,336,866.45
Interest on bonds and lease of other roads	19,193,812.77

RECEIPTS AND EXPENSES FOR FOUR YEARS.

	Gross Receipts.	Expenses.	Net Receipts.
1874—	$ 96,816,868.18	$61,751,129.80	$35,065,736.88
1875—	105,045,788.58	65,732,266.19	40,213,522.40
1876—	107,782,421.77	65,640,200.14	42,142,171.53
1877—	90,042,019.45	61,856,651.59	60,156,367.86

THE annual meeting of the Civil Engineers' Club of St. Louis was held on Wednesday, Dec. 5th, and the following officers elected for the ensuing year:—*President*—Henry Flad; *Vice President*—Thomas J. Whitman; *Treasurer*—William Wise; *Secretary*—Chas. A. Smith. Mr. Chas. Gayler was elected a member.

CORRESPONDENCE.

CLEVELAND, OHIO, *December 11, 1877.*

Editor ENGINEERING NEWS:

Sir.—I would like to inquire through your columns if "Moore Anon," of Cincinnati, can inform your readers on the comparative lengths of his U. S. standard as preserved in the City Engineer's office at that place, and the Chesterman standard if I may use the term as expressed on the steel tapes in common use, taking into account the temperature and tension of the tape when the comparison is instituted. C. H. B.

GALVESTON, TEXAS, *December 1, 1877.*

Editor ENGINEERING NEWS:

Sir.—The communication of your correspondent "Moore Anon" which appeared in your issue of the 24th ult., has reference to a difficulty which is common in many cities in the country, to-wit: that the chain or other meter used in laying them out originally, was incorrect, in consequence of which, measurements made at the present day by a competent surveyor using an accurate chain will not at all coincide with the former measurements. Now what is the latter-day surveyor to do in the premises; if called on to lay out a lot he ought to be able to go into a court if necessary and swear to the accuracy of his work. The question is by what is he to be guided in his measurement. Shall he make his measurements accurately, which would cause his work to conflict with former surveys, and probably throw the lot line in question, a foot or more in advance of expensive buildings already erected on the same block, thereby running the risk of precipitating a first-class law suit, or shall he guess at the location of the lot and judge it in so as to agree with adjoining lots, even though he knows them to be incorrect?

To remedy this matter in some way, several cities have a standing ordinance that all measurements shall be in accordance with a certain standard, which means probably that they must be as inaccurate as the old surveys, and they leave the city surveyor to find out as best he can what that inaccuracy amounts to, and which of course is liable to vary in different parts of the same city.

What I would like to learn, either from yourself or from some of the many engineers who read your paper, some of whom, doubtless have had to deal with this trouble, is, can a city government by an ordinance compel the use of any meter other than that legalized as the U. S. standard, or can a city determine on a standard of its own, which may be greater or less than the U. S. standard, or will surveys made according to such standard hold good in law when opposed to a survey made accurately and in accordance with U. S. standard measure?

This is a matter of considerable importance, and if ventilated through your paper will have the effect of enlightening many as well as SUBSCRIBER.

We hope some of our readers will at once reply to the above communication. We will after a time have some remarks to make on the subject from our experience in city surveying in Chicago. Let us hear from the surveyors at once.—ED.

KEOKUK, IOWA, *December 4, 1877.*

Editor ENGINEERING NEWS:

Sir.—The "Gate City" is the first representative of the enlightened daily press, to favorably notice the laudable efforts of ENGINEERING NEWS, to induce Congress to continue the U. S. Testing Board. It seems a very short-sighted, unwise economy of the House Committee to withhold the needful appropriation. They surely cannot be fully aware of the national importance of early attaining the objects for which the Testing Board was inaugurated. Merely party political considerations should not choke off such an important measure. Congress seems very apathetic to the indignity offered it by the House Committee over-riding its wishes. I think the matter is of sufficient importance, nationally, that the daily press generally should advocate it. A result will be to immeasurably develop the vast and varied mineral resources of this boundless country by assuring public confidence in the superior capabilities of its mineral products and attract an extensive foreign market, as well as increased domestic demand therefor, which now goes a begging for want of authoritative national recognition, and authentication of their valuable superior qualities.

Keokuk has invested $50,000, this season, in grading and macadamizing some of her residence streets, which has enhanced the value of property thereon. Building improvements for the season foots up $160,000, and a public park is promised in the near future. The construction of the water works will be inaugurated in a few days by the contractors. The St. Louis, Keokuk & Northwestern R. R. car shops are now being erected within her borders. This road which is popularly known as the "*Keokuk Route*," has running arrangements over the Chicago & Alton R. R. from Louisiana to St. Louis, coaches and sleepers thus run through from Keokuk to St. Louis without change. The Missouri, Iowa & Nebraska R. R. has established its eastern terminus here, and will run trains into the city by the end of the present month.

The Des Moines Rapids Government Canal has been in operation since the middle of August, and has afforded immense facilities for the navigation and commerce of

the Mississippi river. Navigation above this port has closed and the canal is drain d off, so that the locks, etc., may be thoroughly examined and any needed repairs made, and everything perfected for continued operation early next season. Major Stickney who formerly had charge of the canal improvement in connection with the Rock Island division of the river, under Col. Macomb, has by a recent arrangement of the Secretary of War, been deservedly promoted to the chief charge of this important improvement with headquarters here. It seems to me that the canal is an excellent place for the winter quarters of the Keokuk Northern Line Packet Co's large fleet of packets, and much safer and preferable to that of St. Louis, seeing that immense damage is yearly done to the packets by the destructive ice gorges occurring there in spring, several of the best boats being badly wrecked in this manner last season. The suit of the City of Keokuk vs. the Packet Co., for wharfage, has ultimately resulted in a decision by the U. S. Superior Court, in favor of the city.

The floating ice in the Mississippi at this point is now very thick, making navigation for the few boats running below here very tedious.

The Des Moines River Bridge at this place was completed some time ago. The city's portion of its cost is $35,000. The American Bridge Co. of Chicago had the contract and performed the work in a very creditable manner.

In your issue of March 3d, I called attention to the disagreement between Trautwine and Professor De Volson Wood, relative to the method of calculating certain strains in trussed girders. I have not noticed that the Professor has offered any explanation. I notice in recent Nos. of "Railroad Gazette" a discussion on the strains and functions of various members of a truss bridge girder.

The resumption of the construction of the Keokuk, Iowa City & Minnesota R. R., an enterprise of considerable local importance, is again in abeyance, owing to financial difficulties of the old company, and other obstacles which have proved a barrier to a new company taking hold of the undertaking and completing the road.

ALEX BLACK.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER-WORKS.

There are 400 artesian wells in San Bernardino valley, Cal.

Adequate water supply is now the leading question in Troy, N. Y.

Lewiston, Maine, is to have a new water supply at an expense of $:00.000.

Nichol and Macritchie, Civil Engineers, Chicago, are designing a system of sewerage for Clinton, Iowa. A portion of the plan will be executed in the spring.

A new gas company is being organized in Jeffersonville, Ind., with a capital stock of $25,000. Many citizens have subscribed. This company will apply for a charter soon.

A movement is on foot to establish water works in Springfield, Ohio. The question was voted down three years ago but is more likely to meet with success this time.

San Francisco has just concluded litigation with the Spring Valley Water Company, and it now looks as if she was to be provided with additional legal amusement of the same nature.

A new sewerage system is proposed for Lynn, Mass. The construction of an intercepting sewer is recommended, which shall gather all the drainage that has its natural discharge into the harbor.

The special committee of the city council of Toronto Ont, to consider the best means for carrying on the water works, has appointed a sub-committee to gather information from Hamilton, Montreal and other places. It is believed that $40,000 can be saved in the management of the works.

The new Detroit water works were ready to pump water yesterday. The total cost of the works up to date, including the force main is $771,360.86. A duplicate engine will cost $125.000, and a second force main $200,000 or $325,000 in all. The original estimate was $1,000,000.

The people of Jacksonville, Fla., are discussing a plan by which it is proposed, the county and municipal authorities co-operating with private enterprise and capital, to organize a board of public works with corporate power to carry out the sanitary measures recommended by the Board of Health, without bonding the city.

Bliss Sutherland of Kankakee, Ill., is engaged in digging a ditch seven and a half miles long from an eight-thousand acre tract of swamp land in Newton Co., Ind. The ditch will be 18 feet wide at bottom, 30 feet at top and 4 feet deep. There will also be 30 miles of side drains. The whole cost will be over $30,000. It is expected to complete the work next summer. Lands now worth $2 to $3 per acre, at an expense of $4 per acre will be made worth $30.

The Board of Surveys, of Philadelphia, Pa., on the 4th inst. approved the laying of a 12-inch pipe, at private expense, on the east side of Broad street from the main Sewer to Columbia avenue; the construction of a 3-feet sewer in Berks street between Eleventh street and Park avenue; the extension of the 6½-feet sewer on Master str et from the present outlet to the Schuylkill river; the extension of the Mill Creek sewer, on Forty third street, from Baltimore avenue to Woodland avenue.

On the 23d ult., Little Rock, Ark., passed an ordinance regulating the franchises of a company known as the "Little Rock Water Works Company" recently organized for the purpose of supplying Little Rock on the direct pressure plan. The ordinance occupies nearly three columns of the Little Rock *Daily Gazette* of Nov. 27, and gives maximum rates, etc. There are to be six miles of mains, seventy-five double hydrants; 750,000 gallons are to furnished daiy and the works are to cost not less than $93,000. We believe the contract with the company has been signed, and understand that Denis Long & Co., of Louisville, have the contract for the pipes.

The Boston, Mass., Water Board, has effected a settlement with the Boston, Clinton & Fitchburg R. R. Company for land and grade damages on account of basin for three of the new water works by the payment of $23,000, the corporation to raise the grade of the road-bed lay necessary rip-rap, etc. The Board has further settled with the Washington Emery Mills in Ashland, whose property will be flooded by basin 2, by purchasing the real estate at $30.000, the company to have until October, 1878, to renew the mills and machinery. The Board has also effected a settlement with the Boston and Lowell R. R. company for damages caused by the construction of the Mystic Valley sewer, by paying $20,000. Settlements on the line of the sewer and water works are being made weekly.

Joseph P. Davis, City Engineer of Boston, makes the following report to the president of the Lynn Public Water Board relating to the cost of raising the dam of Birch and Breed's ponds: The estimate for raising Breed's Pond is $6,900; Birch Pond, $3,700. This does not include the value of the land to be acquired for flowage and other purposes. The storage capacity furnished by the ponds with their present heights of dams compared with the areas drained, is unusually large, hence a considerable increase of storage capacity will produce only a very moderate increase in the daily supply. The watershed of Breed's Pond is 520 acres, with a water surface of 59 acres; available storage capacity of the pond, 22,538,000 cubic feet, and if its level should be increased five feet, its capacity would be increased to 3,613,000 cubic feet. With its present storage it may be drawn upon for a daily supply of 650,000 gallons, and by rising five feet the supply would be increased only 50,000. The watershed of Birch Pond, inclusive of hard surface is 490 acres. The area of the pond when full is 68.4 acres, with an available storage capacity of 21,396 000 cubic feet. If its dam was increased five feet, the capacity would be increased 36,947.000 cubic feet. It can be drawn upon now for a daily supply of 600,000 gallons; and an increase of five feet of depth of storage will give an increase of about 65 0.0 gallons in the daily supply.

The bids for constructing the Johnstown, (N. Y.) water works were opened on the 5th inst. The bids were required to be on the blank forms furnished and accompanied by a deposite of $500.00. Following are the proposals: J. J. Newman & Co, Providence, $79.503.00; Patterson, Veeder & Co., Lockport, $56,950.00; J. F. Ward, Jersey City, $53,000 00; McQuade & McDermott, Albany, $53,636,36; Thos H. Reagan & Co., Philadelphia, $51,105. 57; American Gas and Water Pipe Co., Iron Pipe, $58,900.00; American Gas & Water Pipe Co., Cement Pipe, $52,200.00; J. Marsh, North Adams $60,700 00; R. D. Wood Philadelphia, $58,944.75; Barker and Williams, Syracuse $51,531.00; Finnagan and Fields, Syracuse, $54 000.00; Donnaldson and Geer, Fultonville, $49,917.31; S. E. Babcock, Troy, $62,500.00; J. W. Tubbs, Rochester $53.6 0.00; DeLoss Chappeler, Chicago, $56,850.00. There was two other bids, but as they did not comply with the conditions, they were not reported. The contract was awarded to Donaldson and Geer for the sum of $49.917.00. After the awarding of the contract a writ of *certiorari* was served upon James L. Northrup president of the water commissioners, the object being to test the legality of the election recently held and carried by the water men for the building of the works. Mr. Northrup is ordered to appear before Judge Landon, at Schenectady, Dec. 18th. The prosecutors are several prominent citizens of that village.

Recently we saw an item in a San Francisco paper to the effect that the attorney for the Water Commission had not yet examined the abstracts of titles to Blue Lake property, and that the amount of the bond had not been decided upon, as Maj. Mendell, the Engineer of the Commission, had not yet completed the specification for the contract. The San Francisco *Chronicle*, of the 5th inst., says that on yesterday the Blue Lake Water Company failed to file its bond for $3,000,000, and also that John Mullen, president of the Feather River Water Company filed the following document: "The Feather River Water Company, under and by virtue of Section 14 of the Act of the Legislature of the State of California, entitled 'An Act to authorize the city and county of San Francisco to provide and maintain public water works for said city and county, and to condemn and purchase private property for that purpose,' approved March 27th, 1876, are preparing to bring water within the corporate limits of the city and county of San Francisco; and said Feather River Water Company hereby claims a franchise or grant under and by virtue of said Act of the Legislature, to introduce pure, fresh water into the city and county of San Francisco and to lay down mains, pipes, and to maintain water works therein. And you will please take notice that said Feather River Water Company are now actually engaged in doing the work necessary for the construction of water works, to supply the inhabitants of the city and county of San Francisco with pure, fresh water under and in accordance with the provisions of said Act of the Legislature."

RAILROADS.

A railroad is proposed from Ripley to Xenia, Ohio.

Sixty-one miles of the Quebec Central are completed.

The iron on the Midland R. R., Me., is laid to within eight miles of Millville.

There are 4,150 miles of railroad west of the summit of the Rocky mountains.

Work has been commenced on a road between Boulder and Caribou, Colorado.

A survey is now making for a railway from Augusta, Ga., to Knoxville, Tennnssee.

The Cheyenne *Sun*, Wyoming, is advocating a narrow-guage railway from that place northward.

It is expected that twenty-five miles of the Denison & Southeastern Texas will be completed by January 1st.

A narrow-guage road is proposed to run from Columbus, O., over the old National road to Wheeling, West Virginia.

A corps of engineers are now engaged in locating the extension of the Quincy & Pacific Railroad west from Kirksville, Mo.

Surveys are being made in search of the best route for an extension of the Central Pacific Railroad through Lake county, California.

The citizens of Atchison County, Mo., are making a vigorous effort to secure an eastern outlet by building a railway down the Tarkio Valley.

A company has been incorporated to build a narrow-gauge road from Denver, Col., to Central and Georgetown, competing directly with the Colorado Central.

Germany has informed Switzerland that, subject to ratification by the German Parliament, it will contribute a further sum of $2,000,000 towards the St. Gothard R. R.

The Southwestern Railway Company of Minnesota has been organized to extend the Southern Minnesota from Winnebago City westward to the Dakota line, a distance of about 120 miles.

The Denver & South Park Railroad Construction and Land Company have filed articles of incorporation, at Denver Col., the object being to locate, construct and equip the uncompleted parts of the Denver & South Park railroad.

It is stated that Vanderbilt contemplates building a road from Montreal to Norwood, N. Y., connecting at the latter place with the Rome, Watertown & Ogdensburg Road, thus making the route from the west to Montreal shorter than *via* the Grand Trunk.

Whereases and *Resolves* were passed by the New Orleans Chamber of Commerce recently praying Congress for the early building of the Texas Pacific to San Diego Cal., and the completion of the New Orleans branch to Marshall, Texas.

A contract for the final survey and construction of the railroad from Guaymas to the American frontier has been made between the Government of Sonora and Messrs. David Ferguson and Sebastain Camacho. It is reported that work will soon begin on the line.

Construction is very active on the Rochester & State Line R. R. (N. Y.) The gap of 18 miles now existing between the end of the track and Machias will be closed by Jan. 18th, thus completing an important connection with the Buffalo, New York & Philadelphia R. R.

The various country papers in the vicinity of the proposed line of the Toronto and Ottawa R. R., are having an old time-dispute in regard to the most proper and best paying route for the road, all contending that the line by their town would be the easiest and beget the most traffic.

The Turkey Valley branch of the Chicago Dubuque & Minnesota, formerly known as the Iowa Pacific, is being pushed westward from Elkport, Ia., and track is being laid at the rate of about a mile a day, thirty-one miles having been completed. It is expected to complete the road to Hampton next summer.

A Pittsburgh paper suggests the rebuilding of Smithfield street suspension bridge so as to allow the Pittsburgh and Lake Erie, and the Castle Shannon railways to cross over into the city, and that these two roads unite with the Baltimore and Ohio in constructing a union depot in front of the Monongahela House.

The Chicago & Alton Railway Company after much consideration, has finally decided to extend their road from Mexico, Mo., into Kansas City, 162 miles. The entire work, including a bridge over the Missouri river at Kansas City, is estimated at less than $3,000,000. No decision has yet been made as to the time of commencing work.

The people of Galveston, Texas, are memorializing the Court for the appointment of a receiver for the Gulf, Colorado & Santa Fe R. R. company, claiming that the old board of directors have failed, from incapacity or otherwise, to build a road in which the city and county of Galveston are interested to the amount of $500,000.

A formal organization of a company to build a narrow gauge road from Dayton to Ripley, Ohio, was effected in Cincinnati on the 6th inst. The following are the points and distances on the proposed route: Ripley to Georgetown, 10 miles; Buford, 16 miles; Lynchburgh, 12 miles; Martinsville, 6 miles; Dayton, 27 miles. Total 80 miles.

The Illinois Central Railway Company may be expected to take consignments of grain, hog products, etc., for Europe within a few days. Arrangements are now making with the New Orleans & Liverpool Steamship Line for that purpose. The charges on grain will be 70 cts. per hundred, the same as the present rates on the Chicago and Eastern trunk lines.

The Brown Lumber Company's railroad, being constructed from Whitefield, N. H., on the Boston Concord, Montreal & White Mountains road eastward into the forests has now reached the Jefferson Meadows, a distance of 12 miles. It is the intention of the company to extend the road through the Randolph forest to the town of Gorham, a distance of 25 miles, and there make connection with the Grand Trunk railway.

A citizens Committee of East Saginaw, Mich., has had a conference with James F. Joy, in the interest of a railroad from East Saginaw to Vassar there to connect with the Detroit and Bay City railway. It is stated that if the citizens of East Saginaw will donate the right of way and give a bonus of $25,000, the road will be constructed in less than a year. This the committee are unwilling to agree to, as they hope to make better terms. It is beleived that a definite agreement will soon be made and the road soon constructed.

Since the announcement has been made that the Northern Pacific is expected to diverge from the Columbia river at Wallula, the Lewiston (Idaho) *Teller* hopes that the more direct route by the Clearwater will be taken rather than the circuitous one by Pen d'Oreilel, lake. The direct route, it says, would be shorter by 125 miles, with easier grades. Should that route be taken, a northern branch would be necessary to accommodate the country north to Pen d'Oreille lake.

We learn from the Vicksburg, (Miss.,) *Herald*, that the Mississippi and Red River Railroad Company are at work on the railroad between Shreveport and Monroe, just this side of Red River. The company claims to be able to build the road to Monroe without stopping, and after that they will make arrangements to complete it to this city, unless they can make satisfactory business arrangements with the road in operation between here and Monroe.

It is very probable that the gauge on the Jeffersonville, Madison and Indianapolis R. R. will be changed within a few months, and probably all the lines controlled by the Pennsylvania company. Master Mechanic Willis, of the Jeffersonville road, is now in Cleveland, Ohio, and the object of his visit is said to be to consult with Eastern railroad men in regard to the to the proposed change. It is undeastood that the gauge will be made two-thirds of an inch narrower than it is at present.

The Northern Railway from Oakland, Cal., to Martinez opposite Benicia, a distance of 30 miles, is now open for traffic. A ferry is to be placed in the straight and a short line of road from Benicia will connect with the California Pacific to Sacramento. This road avoids the heavy grades of Livermore Pass and will shorten the distance between San Francisco and Sacramento 50 miles, and the time three hours. This road, owned by the Central Pacific, will be used for the overland trains.

A company has been organized to build a railway from Jeffersonville, Ind., to Cincinnati. The road is to run through the counties of Ohio, Switzerland, Jefferson, Scott and Clark, and the entire distance from Louisville to Cincinnati will be 125 miles. It is expected to save some 20 miles of road by making connections with the O. & M. at Aurora, and I. C. & L. at Hardentown. Work is to be commenced at an early day, and it is expected to complete the road to Rising Sun by June, 1878.

The Quincy, Payson & Southeastern Railway, narrow-gauge, has closed a contract for 3000 tons of rails for its eastern division. They are now ready to close the contract for the levee and railway along the bottom from Quincy to Warsaw. The citizens of Adams and Hancock counties are also ready to turn over notes and trust-deeds according to the proposition of the company if within twenty days from the serving of the notice the company give a good and sufficient bond. Everything indicates the early construction of this levee and road.

MISCELLANEOUS.

Missouri thinks of sending an exhibit to Paris; New Orleans ditto.

The funded debt of Philadelphia on the 1st inst. was $61,405,695.18.

The Hoosac Tunnel and approaches are now pronounced complete by Chief Engineer Granger.

Experiments for working steam engines with a petroleum furnace are being made in Newark, N. J.

The River Convention, which met at Chattanooga on the 5th inst. was remarkably harmonious. It wants three millions spent on the Tennessee river in the next three years.

Ten iron ships, aggregating a tonnage of 24,000 have been built by John Roach and Son at Chester, Pa., during the past year. Of this tonnage 7600 tons were for foreign trade.

The public works of Ohio include about 800 miles of canals, that cost $16,000,0000. The canal question is to be submitted to the Superior Court immediately. Meantime a receiver has been appointed.

The city council of Frankfort, K. Y., have taken steps toward building an iron bridge over the Kentucky river at that point.

The Ohio river improvement commission at Cincinnati O., December 12, adopted a memorial to Congress urging the completion of Davis Island dam and lock.

Claims for land damages from the Illinois and Wabash river improvement have been presented to the amount of $184,913 on 19,144 acres. The Legislative Committee recommend the payment of $36,769 on 11,200 acres.

Comptroller Kelly, of New York, in his November debt statement, gives the total amount of the city's indebtedness on the 1st inst. as $123,623,096.78—a decrease of $1,083,150.94 as compared with the same day last year.

The River Improvement Convention which met at Chattanooga, Tenn., on the 5th inst., appointed a delegation of five to visit Washington this winter to urge upon the committee the importance of the Tennessee river improvement.

The mill-owners of Rockford, Beloit, Rockton, and Janesville, Wis., have lately expended $30,000 in the Rock river above Janesville making a reservoir of Lake Koshkonong, so as to afford a stated supply of water during the dryest seasons.

One section of the Paris Exposition will be devoted exclusively to electricity. Tests will be made of the various electrical appliances now in use, and especially of the relative value of the different systems of lighting streets and buildings by means of electricity.

The Tuscarora has been assigned the survey of the Pacific Coast 20° north to Panama. The dangers of this coast are little known, no good hydrographical map existing. The loss of Pacific mail steamer, City of San Francisco, no doubt, hastened this survey.

Dr. Munke quotes a passage from the "Talmud," written in the fourth or fifth century of our era, permitting the use of iron "as a protection from lightning and thunder." Wiederman, in an editorial note, that the Egyptians seemed to have employed gilded masts "for warding off the bad weather coming from heaven."

A Norwegian engineer, according to the *Moniteur Industrial Belge*, has just invented an ice-breaker, to be used in northern harbors to keep them open during the winter months. It resembles a huge plow-share, and is driven by two engines. Two streams thrown backward by means of centrifugal pumps, force the broken ice back into the channel formed.

During the month of November 333 new wells were completed in the entire oil regions, of which fifty-five were dry holes. 461 strikes were made in October. The total number of wells completed during this year is 3,583, of which 603 were dry holes. The total daily production of the entire regions at present is estimated at 37,970 barrels. On December 1st there were 555 wells drilling, against 566 on November 1st, and 367 rigs building against 381 on November 1st.

The Board of Engineers, consisting of Gen. Weitzel Major Benyaurd and Major Howell, appointed to devise a plan to protect certain portions of the river front of New Orleans, from further erosion have agreed upon the general plan of revetting the curving bends with timber, mattresses, facines, etc. The details of the plan and the estimates will not be submitted until the hydrographical survey of the river now in progress is completed. Three parties are now engaged in making soundings and cross-sections. The work is to be done by contract.

A Pittsburgh paper says that the Pennsylvania railroad shops, upper and lower, at Altoona, employ three thousand operators. With the facilities at hand an eight-wheeled hopper-bottom car can be constructed in an hour, and recently 112 of this class were turned out in a week, of ten hours a day. An eight-wheeled box car can be made in nine hours, including one coat of paint, and a passenger car can be built in two days. So far during the year, 5 passenger cars, 5 postal, and 1,771 freight cars have been constructed, and 350 passenger and 9,373 freight cars repaired. The wages of the employés aggregate $1,500,000 annually.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society, Associate of the Institution of Civil Engineers.

ADDENDA.—SPECIFICATIONS CONTINUED.

Continued from page 350.

In good modern practice closely spaced shallow girders are only used where absolutely unavoidable. It is more often found that the distance between cross girders is 7,12, or even 20ft. The latter is an extreme not recommended on the score of economy; for even supposing a saving in the weight of platform, which is not likely to be effected, it would probably not be economical to space the triangulations of the web of the main girders at 20ft. centres, as the compression members would so be rendered unduly heavy. By introducing another system of zigzag, the distance between the cross girders is reduced, and no doubt a saving effected in the total weight of the structure.

These and other kindred questions admitting of no general solution are entirely dependent on the the ability of the designer. In Warren, trellis, and even plate girder bridges, the spacing of the cross girders is in most cases, to a great extent, fixed by considerations affecting the main girders.

So far as approximate weights for taking out strains and parliamentary estimates are concerned, the weight of iron in a properly designed double line bridge platform with two main girders, may be taken at 9 cwt. per foot run, within the limits of 8ft. 6in. and 20ft. spacing of cross girders; that is assuming the iron not to be strained with the heaviest loads to more than 4 tons in the former and 4¼ tons per inch in the latter instance. On the completion of the design there will of course be no difficulty in ascertaining the accurate quantities.

Mr. William Anderson was among the first to appreciate and point out the great economy to be derived from properly spacing cross girders. This is exhibited, apart from any considerations affecting the other portions of the bridge, in the following table of estimates prepared by him, and kept on record in the "Transactions of the Institution of Civil Engineers of Ireland." Vol. viii, 1866.

	Span.	Total load on girders.	Nett area of bottom Flange.	Weight of girders.	Weight per Foot Run of Bridge.
SINGLE LINE.	ft.	tons.	sq in.	lbs.	lbs.
Cross girders 3 ft. apart ..	14	17.26	6.30	1206	402
Cross girders 12 ft. apart..	14	29.35	10.93	1710	268.2
Longitudinal rail girders..	12	19.54	10.80	1818	
DOUBLE LINE.					
Cross girders 3 ft. apart...	25½	35.00	11.40	3654	1218
Cross girders 12 ft. apart..	25½	58.64	19.20	4704	645
Longitudinal rail girders..	12	38.64	21.60	3026	

It may be remarked that the weight per foot run of platform girders given by the author is considerably in excess of that contained in the table. In the former instance the strain on the iron is taken low, and the damaging action of a 45-ton engine is provided for, whilst in the latter the data assumed are—maximum weight of engine 34 tons, maximum load on a pair of driving wheels 16 tons, wheel base 12ft., depth of cross girders $\frac{1}{12}$th of clear span. The ever increasing complications in running powers, taken in conjunction with the various types of engines used on railways, will necessitate the weight given by the author on almost any railway to be constructed in this country; still the relative comparisons exhibited in Mr. Anderson's table hold good, and are of great value. It must not be assumed that in spacing cross girders within the limits of 3ft. and 12ft., that the weight of the platform will vary and be proportional to their distance apart.

There are a variety of considerations affectiug rivets and riveting, some of which it may not be out of place Lere to discuss.

In punching plates the holes become slightly conical, and it is often suggested, and sometimes specified, that the plates shall be placed so that the smaller diameters of the holes come together, in order, to some extent obtain the advantages of countersinking. This is not unfrequently supposed to be carried out in practice, yet it is seldom anything but a supposition. Rivets are not often strained in the direction of their length, excepting in boiler-work and shipbuilding, and so long as the rivet retains its head, this is about the only co idition under which the coneing of the holes can be of much service. In these classes of work, and more especially in the cases of boilers, holes are usually more or less blind, and are seldom filled without the use of the drift. The drift will to a great extent annul the supposed advantages of the coneing of the holes, and in all probability upset the edges of the holes in plates put together in this manner; that is drive the metal between the plates. This is not conducive to the requirement above all others in work of this description, namely a tight joint.

The use of the drift can never under the normal circumstances of actual working be entirely discarded, but it is to be hoped that it will to a great extent at no very distant date, be superseded by the better method of rimering the holes. By this method the holes are punched or drilled slightly smaller than ultimately required, and afterwards, when bolted in place, rimered out to the full size. This operation must be executed with care, as the small iron shavings are very liable to get between the plates. By rimering or drifting the coneing of the holes is necessarily done away with. This is of little consequence as the value of the coneing of the holes entirely depends on the assumption that they are completely filled by the rivets, which although accomplished in experiments is seldom found to be the case in practice. If such were so, owing to the best workmanship not guaranteeing the holes in the various thicknesses of plates being precisely opposite each other, it would be impossible to get rivets out without the aid of the drill; whereas in ordinary work it is only necessary to knock off the head and out comes the rivet even when through four or five plates. With machine rivetting the holes are properly filled so that in addition to speed in execution, and greater economy, there yet remains better work to recommend the employment of machines rather than manual labour in rivetting.

It is sometimes stated that, owing to the contraction of rivets in cooling, the plates are brought into such close contact that the friction between them is sufficient to withstand the working strain without any shearing action coming upon the rivets. This is an important point and one which has been often discussed, it may be well therefore to pass in review the various opinions on the question. Mr. Edwin Clarke, in his work on the "Brittannia and Conway Tubular Bridges," makes the following observations:—

"The contraction of a wrought iron rod in cooling is about equivalent to $\frac{1}{10000}$th of its length for a decrease of temperature of fifteen degrees Fahrenheit, and the strain thus induced is about 1 ton for every square inch of sectional area in the bar. Thus, if a rivet 1in. in section were closed at a temperature of 900 degrees it would in cooling decrease in length $\frac{60}{10000}$ths of its length, and if its elasticity and strength remained perfect would produce a tension of 60 tons. The ultimate strength of rivet iron however being only 24 tons, the rivet would in cooling be permanently elongated, and would continue when cool to exert a tension of 24 tons, provided its elasticity remained uninjured by the strain. Thus if the rivets were not in contact with the plates, excepting at the head and tail, the plates would be held together by a pressure of 24 tons, and this friction would have to be overcome before the rivet came into action as a mere pin."

In order to ascertain how far this theory holds its practice, Mr. Clarke conducted some experiments from which the following are taken;—

Three ⅝in. plates were rivetted together with one rivet in a manner similar to a chain, the hole in the centre plate being oval and considerably larger than the ⅞in. rivet; a weight of 5.59 tons was attached to the centre plate before it slipped which it did abruptly.

The experiment was repeated ⅝in. washers placed on each side of the outer bars, so making the shank of the rivet 2⅜in. in length; under these circumstances 4.47 caused the plate to slide.

The rivet in the last case being assumed to the faulty, the same experiment was repeated and the plates sustained 7.94 tons before they slipped.

"In the next experiment a ⅞in. rivet was inserted through two $\frac{5}{16}$ plates, with large holes, with a $\frac{5}{16}$ washer on each side next the rivet head. This combination supported 4.73 tons before it gave way."

After going fully into the matter, Mr. Clarke infers that the Britannia tubes would not deflect more than they do at present, even supposing all the holes to be too large for the rivets. He also points out that rust must be entirely superficial, the close union of the plates preventing any internal oxidation. His remarks are concluded as follows:—

"Thus also by judicious rivetting the friction may in many cases be nearly sufficient to counterbalance the weakening of the plate from the punching of the holes; so that a rivetted joint may be nearly equal in strength to the solid plates united."

Mr. Fairbairn in his "Useful Information for Engineers," says:—

"From these facts it is evident that the rivetts cannot add to the strength of the plates, their object being to keep the two surfaces of the lap in contact, and being headed on both sides, the plates are brought into very close union by the contraction or cooling of the rivets after they are closed. It may be said that the pressure or adhesion of the two surfaces of the plates would add to the strength; but this is not found to be the case to any great extent, as in almost every instance the experiments indicate the resistance to be in the ratio of their sectional area, or nearly so."

More recently Mr. E J. Reed, late chief constructor of the navy, has had some experiments carried out closely resembling shipbuilding work. They are here given as recorded in his valuable work on "Shipbuilding in Iron and Steel."

"In this place three plates were united by what is known as a chain joint; that is, the ends of the two outer plates overlapped the end of the middle plate The connection of the plates was made by three rivets passing through the lap, the rivet-holes in the outer plates being filled by the rivets, but the bearing surface of the holes in the middle plate were slotted out. It will thus be obvious that when a tensile strain was brought upon the middle plate, the amount of the friction could be measured by the force just able to produce a sliding motion. The breadth of the lap was three diameters, the rivets were a diameter clear of the edges of the plates, and the pitch was four diameters. There were two setts of experiments made with iron plates and rivets, and in each set of two, experiments were made with rivets having heads and points snap-headed; two others with rivets having pan-heads and conical points; and the remaining two with rivets having countersunk heads and points. The experiments were made in duplicate, in order to reduce the chance of error. The first set of experiments was made with ½in. plates, 8¼in. wide, the rivets being ¾in. The results were as follows.

(*To be continued.*)

Paper read before the Liverpool Engineering Society, June 20, 1877.

Capt. Shaw, head of the London Fire Brigade, writes: "No firemen has ever seen a stone stair escape when subjected to much heat; and no internal wall supported on iron can be relied on where there is much heat. At the present moment may be seen at the corner of two streets a new building supported entirely on iron columns without any wall, wood or brick work reaching to the ground along the whole line of the front At the ordinary temperature of from 600° to 700° Fahrenheit the whole building must inevitably fall, and such a temperature could easily be created by the combustion of a small quantity of furniture." The conclusion seems to be that brick or iron, covered with brick and plaster which has been subjected to fire, are the only fireproof materials really deserving the name.

ARCHES;
CONSIDERED GRAPHICALLY.

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(*Continued from page 317.*)

Equating the sum of these two quantities which make up the second member with the first member, we obtain

$$y_1(\sin\alpha-\alpha\cos\beta+\sin\beta-\beta\cos\beta)+y_2(\sin\beta-\beta\cos\beta-\sin\alpha+\alpha\cos\beta)+\frac{y_0-y_1}{\sin\beta+\sin\alpha}(\sin\alpha\sin\beta-\tfrac{1}{2}\cos^2\alpha-\alpha\sin\beta\cos\beta+\cos\beta\cos\beta+\sin^2\beta-\tfrac{1}{2}\cos^2\beta-\beta\sin\beta\cos\beta)+\frac{y_0-y_2}{\sin\beta-\sin\alpha}(-\sin\alpha\sin\alpha-\tfrac{1}{2}\cos^2\alpha+\alpha\sin\beta\cos\beta+\cos\alpha\cos\beta+\sin^2\beta+\tfrac{1}{2}\cos^2\beta-\beta\sin\beta\cos\beta)=r(\beta+2\beta\cos^2\beta-3\sin\beta\cos\beta). \quad (31.)$$

If the arch is a semicircle, $\beta=\frac{1}{2}\pi$, $\sin\beta=1$, $\cos\beta=0$, and (31.) becomes

$$y_1(1+\sin\alpha)+y_2(1-\sin\alpha)+\frac{y_0-y_1}{1+\sin\alpha}(\sin\alpha-\tfrac{1}{2}\cos^2\alpha+1)+\frac{y_0-y_2}{1-\sin\alpha}(-\sin\alpha-\tfrac{1}{2}\cos^2\alpha+1)=\tfrac{1}{2}\pi r.$$

Since $\sin\alpha+1-\frac{1}{2}\cos^2\alpha=\sin\alpha+\frac{1}{2}+\frac{1}{2}\sin^2\alpha=\frac{1}{2}(1+\sin\alpha)^2$, and $1-\sin\alpha-\frac{1}{2}\cos^2\alpha=\frac{1}{2}(1-\sin\alpha)^2$, we get

$$y_0+\tfrac{1}{2}(1+\sin\alpha)y_1+\tfrac{1}{2}(1-\sin\alpha)y_2=\tfrac{1}{2}\pi r, \text{ for semicircle.} \quad (32.)$$

101. The next condition to be satisfied is $\Sigma D E = \Sigma D F$, or, introducing the values of these quantities from the preceding section,

$$r^2\int_{-\beta}^{+\beta}(\cos\theta-\cos\beta)\,d\theta=r\int_{-\beta}^{\alpha}[y_1+\frac{y_0-y_1}{\sin\beta+\sin\alpha}(\sin\beta+\sin\theta)]\,d\theta+r\int_{\alpha}^{\beta}[y_2+\frac{y_0-y_2}{\sin\beta-\sin\alpha}(\sin\beta-\sin\theta)]\,d\theta.$$

Performing the identical integration we obtain

$$2r^2(\sin\beta-\beta\cos\beta)=r[(\beta+\alpha)y_1+(\beta-\alpha)y_2+\frac{y_0-y_1}{\sin\beta+\sin\alpha}(\beta\sin\beta+\alpha\sin\beta-\cos\alpha+\cos\beta)\pm\frac{y_0-y_2}{\sin\beta-\sin\alpha}(\beta\sin\beta-\alpha\sin\beta-\cos\alpha+\cos\beta)]. \quad (33.)$$

If the arch is a semicircle, similar substitutions to those just made convert (33.) into

$$(\tfrac{1}{2}\pi+\alpha)y_1+(\tfrac{1}{2}\pi-\alpha)y_2+\frac{y_0-y_1}{1+\sin\alpha}(\tfrac{1}{2}\pi+\alpha-\cos\alpha)+\frac{y_0-y_2}{1-\sin\alpha}(\tfrac{1}{2}\pi-\alpha-\cos\alpha)=2r;\text{ or,}$$

$$\frac{\pi-2\cos\alpha-2\alpha\sin\alpha}{\cos^2\alpha}y_0+\frac{\alpha\sin\alpha+\frac{1}{2}\pi\sin\alpha+\cos\alpha}{1+\sin\alpha}y_1+\frac{\alpha\sin\alpha-\frac{1}{2}\pi\sin\alpha+\cos\alpha}{1-\sin\alpha}y_2=2r. \quad (34.)$$

102. The third condition, in the modified form of § (67) is that

$$\Sigma D E . D B = \Sigma D F . D B.$$

Since $D B = r(\sin\beta-\sin\theta)$, this condition becomes, by multiplying the previous condition by D B.

$$r^3\int_{-\beta}^{+\beta}(\sin\beta\cos\theta-\sin\theta\cos\theta-\sin\beta\cos\beta+\cos\beta\sin\beta\sin\theta)\,d\theta=r^2\int_{-\beta}^{\alpha}[y_1(\sin\beta-\sin\theta)+\frac{y_0-y_1}{\sin\beta+\sin\alpha}(\sin^2\beta-\sin^2\theta)]\,d\theta+r^2\int_{\alpha}^{\beta}[y_2(\sin\beta-\sin\theta)+\frac{y_0-y_2}{\sin\beta-\sin\alpha}(\sin^2\beta-2\sin\beta\sin\theta]\,d\theta;^*$$

which, when integrated, gives

$$r^3(2\sin^2\beta-2\beta\sin\beta\cos\beta)=r^2[y_1(\beta\sin\beta+\alpha\sin\beta-\cos\beta+\cos\alpha)+y_2(\beta\sin\beta-\alpha\sin\beta+\cos\beta-\cos\alpha)+\frac{y_0-y_1}{\sin\beta+\sin\alpha}(\beta\sin^2\beta+\alpha\sin^2\beta-\frac{\alpha-\sin\alpha\cos\alpha}{2}-\frac{\beta-\beta\cos\beta}{2}+\frac{y_0-y_2}{\sin\beta-\sin\alpha}(\beta\sin^2\beta-\alpha\sin^2\beta+\frac{\beta+3\sin\beta\cos\beta}{2}-2\cos\alpha\sin\beta-\frac{\alpha-\sin\alpha\cos\alpha}{2})]. \quad (35.)$$

If the arch is complete, (35.) becomes

$$(\tfrac{1}{2}\pi+\alpha+\cos\alpha)y_1+(\tfrac{1}{2}\pi-\alpha-\cos\alpha)y_2+\frac{y_0-y_1}{1+\sin\alpha}\tfrac{1}{2}(\pi+\alpha+\sin\alpha\cos\alpha-\tfrac{1}{2}\pi)+\frac{y_0-y_2}{1-\sin\alpha}\tfrac{1}{2}(\pi-3\alpha+\tfrac{1}{2}\pi-4\cos\alpha+\sin\alpha\cos\alpha)=2r, \text{ or}$$

$$\frac{(\pi-2\cos\alpha)(1+\frac{1}{2}\sin\alpha)-\alpha(1+2\sin\alpha}{\cos^2\alpha}y_0+\frac{\cos\alpha(1+\frac{1}{2}\sin\alpha)+(\frac{1}{4}\pi+\frac{1}{2}\alpha)(1+2\sin\alpha)}{1+\sin\alpha}y_1+\frac{\cos\alpha(1+\frac{1}{2}\sin\alpha)+(\frac{1}{2}\alpha-\frac{1}{4}\pi)(1+2\sin\alpha)}{1-\sin\alpha}y_2=2r. \quad (36.)$$

Equations (31.) (33.) and 35 are the equations from which, for a given arch, or angle β and any position of load, or angle α, the values of y_0, y_1 and y_2 are to be obtained. As the equations are of the first degree, when the numerical values of α and β with their sines and cosines are introduced, their solution presents no difficulty, although it may be rather tedious.

Equations (32.), (34.) and (36.) apply only to the semicircular rib. They may be somewhat reduced, and y_0 may be eliminated by the following steps. Multiply (34.) by $1+\frac{1}{2}\sin\alpha$, subtract (36.) from the product, and then subtract the remainder from (32.) multiplied by α. The resulting equation will be

$$(\alpha+\tfrac{1}{4}\pi-\tfrac{1}{4}\pi\sin\alpha)y_1+(\alpha-\tfrac{1}{4}\pi-\tfrac{1}{4}\pi\sin\alpha)y_2=(\tfrac{1}{2}\pi\alpha-\sin\alpha)r. \quad (37.)$$

Then multiply (32.) by $\frac{\pi-2\cos\alpha-2\alpha\sin\alpha}{\cos^2\alpha}$ and subtract (34.), obtaining

$$y_1+y_2=\frac{\frac{1}{2}\pi^2-\pi\cos\alpha-\pi\alpha\sin\alpha-2\cos^2\alpha}{\pi-2\cos\alpha-2\alpha\sin\alpha-\frac{1}{2}\pi\cos^2\alpha}r. \quad (38.)$$

It will be easy to find y_1 and y_2 from (37.) and (38.), as soon as the proper quantities are substituted for α and its functions, and y_0 can then be found by substitution in (32.)

103. When the desired ordinates for any arch are computed, we have the option of obtaining the values of H, of the vertical components of the abutment reactions, and of the ordinates for bending moment, either by graphical construction or by formulæ similar to those applied to the parabolic rib. By noticing the expressions to be used for b, c and k in the case of the circular arch with hinged ends, one can readily adapt the formulæ of § 70 and § 72 to the computations for this case. The ordinates to the circular arc will be the same as the preceding case § 94. As the arch may subtend any angle, it will not be expedient to go into calculations here for any special values of β.

104, We may however obtain the ordinates y_0, y_1, y_2 for a complete semicircle with comparative ease, and as such a rib is sometimes used for large roofs, these values may at times be convenient. Semicircular masonry arches, having backing above the abutments, present a different case. If we write $\pi = 3.1416$, the three equations (32.), (35.) and (36.) become

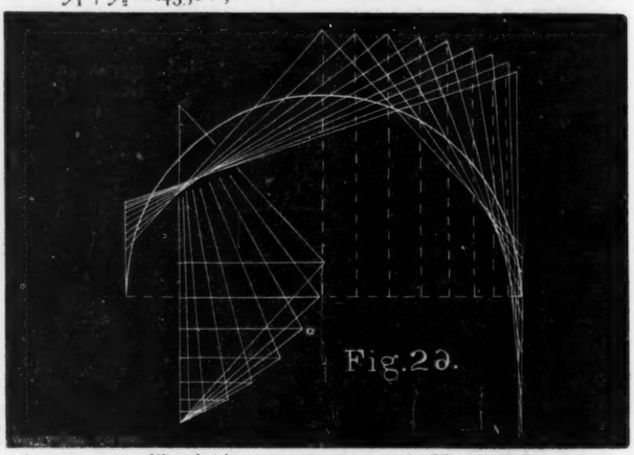
$$y_0+\tfrac{1}{2}(1+\sin\alpha)y_1+\tfrac{1}{2}(1-\sin\alpha)y_2=1.5708\,r,$$

$$(\alpha+.7854-.7854\sin\alpha)y_1+(\alpha-.7854-.7854\sin\alpha)y_2=(1.5708\,\alpha-\sin\alpha)r, y_1+y_2=\frac{4.9318-3.1416\cos\alpha-3.1416\alpha\sin\alpha-2\cos^2\alpha}{3.1416-2\cos\alpha-2\alpha\sin\alpha-1.5708\cos^2\alpha}r.$$

If α is taken as 20° or .3491; $\sin\alpha=.3420$ and $\cos\alpha=.9397$. The second and third equations become

$$.8659\,y_1+.7049\,y_2=.2064\,r;$$

$$y_1+y_2=.4358\,r;$$



whence we readily obtain $y_1=.3270\,r$, $y_2=.1088\,r$, and, by substitution in the first equation, $y_0=1.3156\,r$.

If the computations are carried out for other values of α, we shall complete the following table for a semicircular rib with fixed ends:

α	y_1	y_0	y_2
0°	.2409 r	1.3399 r	.2409 r
10	.2878	1.3264	.1827
20	.3270	1.3156	.1088
30	.3596	1.2934	.0108
40	.3971	1.2751	− .1248
50	.	1.2453	− .
60	.4344	1.2100	− .6652
70	.4546	1.1701	−1.3335
80	.4750	1.1246	−3.3187

Other intermediate values can be obtained, if desired, by the formula for interpolation in § 52. The number of decimals it is desirable to use in any particular case will depend upon the value of r. The curves of equilibrium for these ordinates have been drawn in Fig. 26, and from them we get the different values of H, for a weight W at the several divisions, as shown in the accompanying stress diagram.

* $\int\sin^2\theta\,d\theta=\frac{\theta-\sin\theta\cos\theta}{2}$. See also note to § 91.

TROY, N. Y.

Three thousand years is not so long a time after all. The stranger who visits the Troy of to-day can troop up a host of classic associations, mostly *bouffe*. The flocks and herds as of old disport themselves on the Albian hills; Paris and Helen still reside on Mount Ida, but undisturbed by revengeful Menelaus, and Jupiter and Juno, in pleasant dalliance, again forget to watch from Mount Olympus the great but bloodless conflict of giant industries and commerce below. Like her namesake of old, *our* Troy is clustered about the throat of a mighty commerce. It is not the Dardanelles through which Jason sailed away to the Euxine after the golden fleece, but the dirty Erie canal leading westward to the great lakes and the marts of the golden harvests, and the noble Hudson leading south to the mighty metropolis, and thence to the worlds across the sea. The beautiful valley is picturesquely embosomed to the northwest in the everlasting Adriondacks, and in their ample folds are built those great matrimonial boards of trade, Saratoga and Ballston.

The Champlain region stretches northward after the crude products of the frigid Scyths. Railways radiate in all directions north, east, south and west, and the mighty Hoosac bore places the chaste and classic Hub at her gates.

Three miles to the northwest, at the falls of the legendary Mohawk, is the busy manufacturing city of Cohoes with its 20,000 inhabitants. A different "spirit" now broods over the brink of the cataract as the waters are led away in prosaic canals to turn the busy spindles of the Harmony mills; every Saturday afternoon six thousand Helens march out to board the classic street car for Troy, there, on the crowded street, to divide with the collar and shirt girls the smiles of the gentle Parises of the Institute.

Lansingburgh, with its 7,000, bounds Troy on the north; opposite Lansingburgh and Troy lie first Waterford with its 3,500, further down Green Island with 5,000, and still again West Troy with 13,000 more, all busy with trade and manufacture. Here lived and died that modern Achilles, John C. Heenan, and opposite, old Troy herself with its 55,000, claims the present Ajax, John Morrisey, all her own. Picayune towns outlie on every had, and six miles below, Albany, with its 80,000, rears a State capital high to heaven, and founds it deep in shekels and taxed curses.

Within a radius of ten miles from Troy may be found nearly 250,000 population, and these busy places, some day, London-like, will unite in one great town. This vicinage boasts great and varied manufacturing industries. In iron works it is next to Pittsburgh. The stove works, bell foundries, car shops and cotton mills are second to none. In shirts and collars it controls the markets. The manufacturing of engineers' instruments is one of the largest. Valve works, brass works, machine shops, and hundreds of other industries characterize this region as one purely manufacturing. Here lived John Griswold of Monitor fame. Here the first Bessemer steel works in this country were erected. Here Burden, with the aid of his educated and scientific wife, made the first horse-shoe machine. The works that he constructed, located on the Poestenkill, are yet among the largest in the country. The machinery is operated by a scientifically constructed over-shot water wheel sixty feet in diameter, and only second in size to the great seventy-two feet wheel of Wales. Here the first street car system was inaugurated on an extensive scale in this country, the numerous outlying large towns close at hand being so situated as to peculiarly favor its development; and Jones & Co. of West Troy, for a long time supplied nearly all the street cars used in this country. Here also for many years were made nearly all our stoves and bells, and to-day these industries are well represented in our trade. On Green Island Gilbert, Bush & Co. turn out the Wagner coach and build extensively in passenger cars, and have already worked up a South American trade.

The topography of this region is peculiar. A narrow flat of a half-mile width extending for five or six miles along the river, contains all the business and the chief residence portion of Troy and Lansingburgh on the east side, and West Troy, Green Island and Waterford on the west. Cohoes is situated mainly on the bluff slope near the falls of the Mohawk. The bluff is, for the most part, quite precipitous, and, except in the vicinity of Mount Ida, the residence portion of Troy proper is just beginning to creep up to the healthier table-land above. The Mohawk, emptying by several mouths, forms three islands, one of which is called Green Island: the other two, though beautifully situated above the dam, and very desirable for residence, are not yet connected by bridges to Lansingburgh and Cohoes. When this is done they will be a fortune to their owners.

The fine masonry dam built by the State, 151 miles from New York, marks the limits of tidal flood and the head of river navigation. Hereare situated large paper and flouring mills, and above the dam the three miles of still water furnish the course for the Olympic contests of the classic oarsmen.

Two noble bridges span the Hudson below the dam, one railway and one road, and two great railway bridges again span the river at Albany. The virtual termini of the Champlain and Erie canals are here, and in the future at this point will begin the slack-water system of the Upper Hudson, to connect with a short canal to Whitehall on Lake Champlain, giving a 14 ft. water route through from New York to Montreal and the St. Lawrence; also a similar water line to the Great Lakes *via* Oswego.

Troy was settled by the Dutch in 1752, and incorporated as a village in 1801. Thrice the gods have scourged her with fire, virtually destroying her business portion, the last time in 1860. Thrice has she energetically risen from her ashes purified sanitarily, but with no apparent increased wisdom. In the last fifteen years she has grown rapidly, and the future prospects for her and her near neighbors are bright indeed. Troy and its vicinity, for extensive engineering works and manufacturing interests, is probably above most places in the land instructive to the engineer and technist.

Troy has also to a certain extent a classic fame to engineers. Here, in 1824, was established the first scientific and engineering school in the land, and for a long time the Rensselær Polytechnic Institute was alone in the field. She turned out educated engineers, when an educated engineer in this country was looked upon as an unpractical theorist, then synonimous with "fool." Things are changed now, and her 400 graduates can boast of having directed much of the best work of this country.

All this will make plainer what we started to write about, but from which unclassical travesty has caused us to wander. The city of Troy, although filled with progressive men, so far as their individual interests are concerned, although the home of great wealth and apparent intelligence, in her public spirit as regards municipal improvements is as dead, illiberal and unprogressive as the Board of Trustees of the Rensselær Polytechnic Institute. The travesty on classical lore contained in her names and surroundings seems to have wedded her to gods eminently unprogressive and too far behind the times for the present era. Her sewerage system is very faulty, and her waterworks are an abomination to all but the filthiest of gods. Her streets are nearly as vile as those of Chicago, and suggest that if some of her mediums would only materialize Hercules he might perform a feat far transcending the cleansing of the Augean stables.

The country to the east of Troy is hilly, full of ponds and lakes, and is chiefly drained by the Piscawenkill, the Wynantskill and the Poestenkill, all streams of rapid flow, emptying into the Hudson within corporate limits, the latter two affording considerable water power. The waters of the Piscawenkill were many years ago impounded in a storage reservoir, but not of sufficient height to supply the city above Eighth street. With the extension of the city mains this has proven quite inadequate. The supply itself was not always of a desirable quality. Every freshet imparted an unpleasant turbidness to the waters. The last time we visited the frog-pond on a warm June day, it was without a fence even, and the bovines from a thousand hills standing to their bellies in the "limpid" wave, were ringing their tails in dire vengeance against the frisky but circumspect fly. We reflected that it wasn't so bad after all to know that the city milk-herd bathed in and drank from the same "pellucid fountains" as the citizen. For some time the supply has proven inadequate, and water has been pumped by a Flander's pump and turbine at the State dam to the reservoir.

For many years there has been a sort of sleepy purpose to build new works adequate to the present and prospective needs of the city. Some years ago what is called the Tomhannock scheme was investigated in some detail. The scheme involves some fine engineering possibilities and magnificent costs, and in the presence of nearer and cheaper supplies is hardly to be considered. Both the Wynantskill and the Poestenkill have been urged as sources of supply, and, considering the character of their drainage basins, there can be no doubt of a supply from either of them equal to the Boston supply in purity and at a comparatively moderate expense. Direct pumping from the Hudson is urged as an alternative scheme.

Mr. D. M. Green, the engineer employed, estimates the cost of the Wynantskill plan at $825,000, and the Poestenkill plan at $711,285. In the first case $210,000 is estimated for a 4 ft. brick conduit 8 miles long, and in the second a similar conduit is estimated at $102,300. In each case the compensation for water rights is estimated at $500,000. The plan advocated by the engineer, however, is to establish pumping works on the Hudson at an expense of $200,000. The cost of maintenance of the Wynantskill plan is estimated at $8,510, and of the Poestenkill, $4,225, and of the pumping plan, $15,300.

If Troy was ever interested in any proposed public improvement, she is interested now; she would even get excited if she were capable, of so much emotionalism. The "chief engineer" of the Troy *Whig* has buckled on his armor and marshalls "horse, foot and dragoon" against Mr. Green and his plans. He is evidently impressed with the idea that he has a mission to fill, and he endeavors religiously to fill it to the extent of two columns a day. From his own stand-point he clearly makes out Mr. Green to be a metaphorical ass. He utterly repudiates the $500,000 estimate for extinguishing water-rights in the two "kill" schemes, and the conduits are asserted to be utterly unnecessary, and how it should be done is set forth at some length. The estimates for maintenance are set entirely too high in these cases, and for the pumping plan it is put at $21,000 for current expenses in place of $15,20 . If the Hudson plan is to be adopted at all, why not put in additional pumps at the dam, and for a first outlay of $10,000 and an annual expense of $8,000, get the same supply of water for which it is proposed to expend $200,000 and $40,000 thereafter annually. Th Hudson is condemned as a source of supply in unstinted language as contaminated with the sewage of Lansingburgh, Cohoes, Waterford, etc., Mr. Green's whole plan is condemed as inadequate to supply the whole city properly; and finally it is suggested that pumping works constructed on the rifts above Lansingburgh would be above sewerage contamination, no filtration would be required, and abundance of water power would be available, etc. It appears that three non-resident engineers were appointed by the Water Commissioners to report upon the various schemes, and these were furnished with the plans, estimates, reports, etc., rode where the chief engineer chose to take them, and "handicapped and hoodwinked by Mr. Green and Mr. Fales, have failed to touch upon the vital point at issue," etc.

Of the merits of the various schemes we do not propose to deal. It would seem as if all this smoke could hardly be occasioned by a mere holiday salute. The *Whig* Engineer writes evidently from first principles, as he has lifted himself entirely above precedent. Albany is supplied with water from the Hudson, contaminated by the additional sewage of a great manufacturing region and 70,000 population, above what the proposed works at Troy would receive. West Troy has just been supplied from the Mohawk above Cohoes after it has received the sewage of Rome, Utica, Little Falls, Schenectady and a host of minor towns, and a rich and populous valley. The supply of Troy diluted by the waters of the Upper Hudson certainly could not be as bad as that of West Troy, and infinitely better than that of Albany.

In the case of either Albany, Troy, West Troy, or any of the minor towns which must soon be supplied from some source, whatever analysis may say as to their purity, we should very much doubt the wisdom of using the river waters after so much contamination, were

other sources of supply available at a reasonable cost. The Hudson above Waterford, furnishes this source, or any of the numerous upper tributaries can be utilized to give a gravity supply hardly equalled in purity by any supply in this country. It may be said that these small individual cities are unable to avail themselves of it on account of the expense. Along the banks of the Hudson in a distance of ten miles exist the towns of Waterford, Lansingburgh, Cohoes, Green Island, West Troy, Troy, Albany and Greenbush, containing an aggregate population of nearly, if not quite, 200,000, and destined to double in population in the next generation. Had commissioners, with this whole vicinage in charge, been appointed ten years ago, it might have been ere this very efficiently supplied under one comprehensive scheme, and at a cost far less to the individual muncipalities. Now some of the smaller "bergs" must go without, and all must drink water more or less contaminated. Various plans could have been adopted. The one suggested on first thought is to build a dam on the rifts above Waterford, establish there a pumping station, and pump by water power into a high level storage reservoir, for which ample sites can be found near at hand. Then a conduit with local distributing reservoirs could supply all the towns and cities to Albany and below. Sites for such reservoirs are abundant.

Municipalities are, after all, nothing but individuals, and often go forward best when you try to drive them in an opposite direction. If Washington Irving could rise from his ashes we opine that he might yet find in Albany and Troy ample material for a revised edition of the Knickerbocker history.

THE new Constitution of Georgia prohibits perpetual charters with special privileges, fixes freight and passenger tariffs, and prohibits all discrimination. The State is prohibited from lending aid to railways.

IN consequence of some glaring discrepancies between the plans and the possibilities of the ground, the City Council of Utica, on the 14th inst. annulled the contract with Messrs. Finnegan & Field for a large sewer over a half mile in length, then under construction, and suspended, summarily the City Surveyor, Mr. Kinney.

THE Inter-State Commission for the development of the Ohio river, met at Cincinnati on the 12th inst., the seven river States being represented. Speeches were made and a memorial adopted setting forth how much revenue had been derived from the States mentioned, and how little had been returned to them in public improvements, and also how this region had been sacrified to harbor improvements on the seaboard. An appropriation for the immediate completion of the Davis Island dam is prayed for.

FROM a reportorial narrative of the trip of Gov. Cullum of Ill., the officials of the Illinois Central R. R. and others to the jetties, we extract the following:

The dredge boat used holds five hundred cubic yards; is filled in six minutes; makes a trip to the mouth of the jetties in about five minutes to empty, and the time consumed in emptying is about three minutes. The material dredged out during the stay of the visitors consisted of 50 per cent of mud and the remainder water. When a sand bar is encountered the percentage of sand is larger. At times the character of the material taken out is almost pure clay, and pressed, or alowed to bake in the sun, forms a hard substance.

THE Toronto *Mail* of the 11th inst. has a lengthy editorial on the Toronto & Ottawa Railway, urging its merits purely as a local line and as a possible competitor to Grank Trunk to Montreal, and also a feeder to the Intercolonial and its winter port, Halifax; it deprecates the idea of its furnishing a link in a new through line to Boston or other ports, which, it states, has been urged to the ratepayers of Toronto as an argument for its construction, and concludes that Grand Trunk must for many years be the main through line for the Dominion; yet "regarding this line as necessary to complete our railway system, we could not advise any ratepayer, whatever his objection to it may be, to vote against the by-law."

The by-law is to be voted for on the 20th inst. The proposed road is 225 miles in length, traverses nine counties and passes through several important towns and villages. It is estimated to cost $20,000 per mile, or $4,500,000 in all. There is a private stock subscription of $100,000. Toronto will grant a bonus of $300,000 if the proposed by-law passes, and the $100,000 additional, which will probably be raised along the line, will make a municipal subsidy of $5,500 per mile. The Province of Ontario is expected to grant a subsidy of $4,500, making the entire subsidy $10,000 per mile. If this subsidy is obtained the company have power to grant first mortgage bonds to the extent of $15,000 per mile,—and thus be in position to commence work at several points on the line next spring or summer.

NEW ORLEANS, Dec. 16—A dispatch from Port Eads says the official survey of Captain M. R. Brown, United States Army, inspecting officer at the jetties, shows a twenty-two foot channel over 200 feet wide entirely through the works, which entitles Mr. Eads to a second payment of $500,000. A practicable channel through the jetties was found, with a least depth of twenty-three feet,

No additional particulars have been received up to the time of going to press. While all good citizens rejoice over the success of the engineer, let the croakers take a back seat until the festivities are completed and the prize awarded.

THE ninety days limit for the presentation of competitive plans for the new State House at Indianapolis expired on the evening of the 17th. Twenty-four plans have been submitted. The State House Commissioners have appointed J. C. Wilson, architect, Cincinnati; Capt. C. W. Allen, engineer, Vincennes, and Henry C. Walters, builder, Jeffersonville, as experts to examine and report upon the plans submitted. They are expected to complete their report in a couple of months, and as soon thereafter as the working plans can be matured and estimates made, the various contracts will be let. The Commissioners expect to advertise for the foundations in April next. Twenty-three quarrymen have submitted sixteen different specimens of stone for the building.

"THE Hudson Tunnel Railroad Company" was formerly incorporated on the 20th of May, 1873, under charters from New York and New Jersey, with a capital of $10,000,000 divided into 100,000 shares in the proportion of 30,000, under the New Jersey charter, and 70,000 under the New York charter. The tunnel was originally designed to be 20 ft. wide and 24 ft. high. The Jersey City depot will be on Jersey avenue, 1750 feet from the waters edge, and the New York depot on the block bounded by sixth ave., Fourth, Macdougal and Amity streets. The tunnel will be some two miles in length. The Jersey City depot will connect with all the railways entering that city, from which they will be run through the tunnel to the immense Union depot in New York. Should this enterprise prove pecuniarily successful, it is the intention to continue the tunnel under New York city and the bed of the East river to Brooklyn. Such is a brief outline of one of the most important proposed public improvements.

Work was commenced over three years ago by sinking a brick shaft some 30 feet in diameter on the Jersey shore, but ere it had reached a depth of 20 feet, an injunction was served by the Delaware, Lackawanna & Western Railroad and the Hoboken Land and Improvement Company, followed by a long and vexatious litigation, recently terminated in favor of the tunnel company. It is the design of the company to sink the Jersey shaft to a depth of 65 feet, and after the tunneling is fairly under way to commence work also from the New York shore. When the work is fully inaugurated it will employ about 500 men three years to its completion.

The original design was to use a Brunel shield in conjunction with compressed air to drive the headings, the material being removed to the surface through pipes by the pressure of the air, as practiced in the caissons of the East river bridge and elsewhere. Recently, we learn from the *Iron Age*, Chief Engineer, W. H. Paine, formerly connected with the East river bridge, has expressed doubts as to the use of compressed air in this instance, and also as to the policy of making a double-track tunnel in place of two smaller tunnels. So it would seem that the plans are not yet fully matured. When the character of the work is considered, the tunnnl being in part through serpentine rock and in part through silt of very treacherous nature, this must prove one of the most interesting of modern engineering works.

THE Chamber of Commerce of New Orleans has prepared a long and able memorial to the powers at Washington praying for subvention to American built American-owned steamship lines from that port one semi-monthly to Rio Janeiro, and the other semi-monthly to Aspinwall. After reciting the natural advantages of New Orleans as an outlet to the commerce of the Mississippi valley and a portion of the Great Lakes, and the facilities for bringing their products to that port for foreign shipment, especially to tropical countries, in place of the expensive and unnatural route by Eastern ports, it says:

"This unequal and unnatural course of commerce is entirely attributable, as your memorialists conceive, to two principal causes:

"1. The want of proper commercial treaties and conventions between our government and those of the countries and colonies referred to.

"2. The want of adequate facilities of commercial intercourse between the United States and especially its Western interior, and the countries and colonies referred to."

It illustrates these points at some length by reciting the tariff duties imposed on American products by these countries, and argues ably for reciprocity treaties, Statistics are given as to the relative importance of our commerce with these countries as compared with that of foreign nations.

Subsidized lines are advocated and figures are given to show that the postal receipts over the lines hitherto established, have more than repaid the amount of the subvention. The English subsidies to South American and West Indian lines is given as $930,000, and the French steamship subsidies to the same countries are given at $1,449,451, besides lines of German steamers.

The advantages of reciprocal trade with these countries are recited at length and fortified by numerous statistics, and the present policy of the country condemned.

"It would be proper to divide this continental commerce and postal service among these great longitudial districts:

1. The eastern Atlantic States and seaports.
2. The Pacific States and seaports.
3. The States lying between the Appalachian and Rocky Mountains.

Each of these great commercial districts should be provided with equal and adequate facilities for postal communication with its peculiar and appropriate continental territory."

The memorialists, however, confine their prayers to their own commercial district, and ask of Congress

1. An appropriation for the two steamship lines previously mentioned.

2. A review of all existing commercial treaties and conventions between the United States and other powers of this continent, with a view to their revision in a manner such as to promote the fullest trade relations.

3. That the senators and representatives in Congress representing the interests presented by this memorial, extend and advocate legislative aid, etc.

We do not intend to discuss or advocate any particular method of arriving at the results advocated in the memorial, as it soon assumes a political phase foreign to the purpose of this journal.

The condition of our foreign commerce, especially as respects foreign ports on this continent, is certainly discreditable, and that it should be remedied in some way is patent to every thinking man. That many of our important cities as New Orleans, Baltimore, Philadelphia and others, are waking up to the desirability of taking a leading part in this trade, and are taking active steps toward the realization of this object, is certainly very gratifying, and worthy the attention of every journal. A large share of the public works of South America have been, and are being, constructed by American engineers, or by native engineers educated in this country. With efficient trade relations these benefits will fall to a still greater number of out engineers as well as to our contractors and manufacturers.

One of the spans of the Rock Island bridge was wrecked on the 15th inst. by the derrick of a wrecking car too high to pass the bridge. One man killed and trains delayed twenty-four hours.

TO HYDRAULIC ENGINEERS AND SUPERINTENDENTS OF WATER WORKS.

In presenting the "Water Supply of American Cities" as the leading subject of ENGINEERING NEWS during the coming season, it cannot be expected that we are going to write a carefully prepared treatise on it; to accomplish such a task would involve years of labor in accumulating the materials, and then again considerable time in arranging and presenting them in a proper manner for the class of readers for whom it was intended. Our purpose is rather to present in a condensed form what has already been accomplished in the construction of water works in this country; to describe existing works with their modes of supply, their pumping machinery and method of distribution; to give an account of the difficulties attending particular cases, and the engineering devices employed in overcoming them; to tabulate results of the years of experience already gained, and if possible arrive at some generalizations therefrom. We have to take a broader view of the subject than would be taken by an author writing simply for the profession, as we expect to treat of questions for the edification of the people who are to vote upon the subject of a public water supply; for newly appointed Boards of Water Commissioners; for investors in Water Bonds; for the manufacturers and dealers in all classes of supplies for water works, besides that portion of the engineering profession who make a specialty of hydraulics. The arrangement of all this material from week to week must necessarily be independent of any regular plan; to some future author must be left the task of re-arranging it for publication as a separate treatise. Now there are a multitude of practical questions relating to a public water supply which are known only to those men who are constantly engaged in their construction and management, and we earnestly solicit from such the results of their experiences. We will be glad to receive suggestions as to the particular information desired and we invite the active and earnest co-operation of the professional constructors, and practical superintendents of water works throughout the country in our efforts during the next season to show the importance of a public water supply; the methods of proceeding to obtain it; the best machinery to be used, the cost, and the multitude of other questions that must interest every community where a pure and abundant supply of the necessary fluid is desired. After a considerable correspondence we have hardly accomplished anything but a realization of the magnitude of the undertaking we have ventured upon, and judging from the small success we have had in obtaining answers to our inquiries, we see no other method than ultimately to make a personal visit to the most important water works and applying the "pumping process" to the superintendents individually. But a great deal may be furnished by those of our subscribers who are able to give the information if they will take the time to write it, and we hope that our appeal may not be in vain. Write us at once.

[Special Correspondence ENGINEERING NEWS.]

THE HARBOR IMPROVEMENT WORKS, QUEBEC.

Our readers may have noticed, early in the present year, an advertisement inviting tenders for the construction of works to improve and extend the harbor of Quebec. A recent visit to that "quaint old city" gave us an opportunity to become acquainted with the proposed extension, and to note the progress attained during the past season.

The "close of navigation" marks the natural suspension of all navigation interests, as also all public works. At the time of our visit, although the river was as open as in summer, the "fiat" had gone forth, and a quiet marked the river and site of the New Harbor strangely at variance with the activity of the "season." Then a commercial activity exists perhaps unequalled by any other port so far removed from the seaboard.

It will be observed by a glance at the map, that Quebec is situated upon a point of land formed by the confluence of the river St. Charles with the St. Lawrence, the apex of which is called "Pointe a Carcy." From this point the city quay line extends in a direction south-west by south on the St. Lawrence river, and on the St. Charles north-west by west: it is upon the latter side, extending from the point, that the New Harbor is located.

The main feature of the proposed work consists in the closing a given area of deep water by a quay wall or embankment, the eastern boundary of which is formed by adapting into the scheme a wharf already in existence.

This quay or embankment was originally designed 200 feet in width, but it is now intended to increase it to 300 feet.

The exterior or river face commences from the west at the gas works wharf and extends in a north-east direction 746 feet, thence it continues almost due east for a distance of 3,130 feet, and again bending to the south connects with the Ballast wharf, already in existence, 530 feet from the last angle.

The interior or harbor face of the quay also begins at the gas works wharf, runs 455 feet parallel to the outer face, when it bends and continues a course equidistant from the river face for a distance of 3,670 feet, connecting with the Ballast wharf at its re-entering angle, and at its northern extremity.

We may add that the Ballast wharf, which lies in a southwest direction, is 800 feet long on its inner line and 900 feet on the outer or river face, and until it became a part of the present design, it was an isolated structure separated from the Commissioner's wharf by a water-way 187 feet wide. This water-way will form the entrance to the new harbor.

The method of construction adopted is to deposit a toe-ing of heavy stones or *pierre perdue* to protect the foot of the slope forming the outer or river surface of the quay, and continuing the earth-work therefrom at a slope of 1½ to 1 up to coping level. To prevent washing it will be carefully re-propped—at both ends of the embankment,—on the west where the current of the St. Charles impinges, and at the east where it meets the deep waters of the St. Lawrence, timber cribs filled with stone will be sunk and continued to 9 feet above low water, from which height up to coping level the pitching will be laid, conforming to the plan adopted on the other portion of the bank.

The inner face or wall of the quay will be constructed of crib-work caissons, 28 feet deep by 30 feet wide. These caissons are so arranged that within them, and next to the water, a solid wall of Portland cement concrete of 10 feet in thickness, with numerous counterparts, can be deposited. The concrete wall will be backed with clay and ballast, selected and carefully rammed, and sloped to take its own angle of repose. The wall from the top of the caisson—four feet above low water—will be built with a stone face to 6 feet above high water, making a perpendicular height of 20 feet of masonry, or a total depth of quay wall of 48 feet from the bottom of the concrete foundation.

The filling between the outer slope and the inner wall of the quay will be formed from the material dredged from the inclosed basin; this will be carried up to a given level and probably paved or metalled with macadam, making an esplanade of 300 feet wide from out to out.

In the basin or harbor formed by the quay wall and by the side thereof, a channel will be dredged 150 feet in width, sloped on the farther side at an angle of 1½ to 1, and extending the whole length of the wall. This channel will be excavated to a depth of 24 feet below low water level over a portion of its area, and to 10 feet in depth over the remainder; this will give respectively 42 feet and 28 feet of water at high tide.

As part of the harbor scheme it is proposed to extend Dalhousie street until it meets the quay wall in course of construction, and ultimately, in all probability, to build a transverse wall or embankment with an entrance, so as to enclose a large area of water, forming a wet dock with a uniform depth at all states of the tide of 28 feet. Near the Commissioners wharf at the east end of the harbor, there may be constructed in the future, a lock available for ingress or egress at all states of the tide.

It is also proposed to extend the North Shore Railroad, now in course of construction and nearly in running order, between Quebec and Montreal, along the entire length of the embankment from its extreme west end to the south end of the Ballast wharf.

As regards the comparative size of the new harbor, it may be said to be, when completed, one of the largest wet docks in the world. We were somewhat surprised to find so little apparent from which to judge of the progress already made in this large undertaking; but when we consider that much time must necessarily be spent in preparing for such a work and that a large proportion of the whole lies under water and out of sight, our surprise vanishes. To determine the character of the plants required and the material to be removed by dredges caused considerable delay; but the contractors, Messrs. Peters, Moore and Wright, of Quebec, have now become so thoroughly acquainted with the nature of the work, that the experience of the past season will materially aid towards rapid progress next year.

All that has been so far accomplished is, that the cribs for the protection of the embankment at its east and west ends are in place and filled, and a considerable quantity of material has been dredged from the inner channel.

It was found absolutely necessary to employ one of the largest and most powerful of "dipper dredges" in the excavation from the quantity of large boulders scattered throughout the material to be dredged.

The dredger in use has double engines of ninety horse power nominal with auxiliary engines of fourteen horse power with which to work the derrick and dredge spuds. With this power the machine has raised, from the bottom, boulders varying from three to nine tons in weight, and has proved itself the proper "dredge" for such work.

In connection with the improvement on the Quebec side, a graving dock is about to be constructed on the south side of the St. Lawrence, at Pointe St. Joseph, neatly opposite the new harbor. Plans for this dock have arrived from England, and tenders will be shortly invited. The dimensions are: length, 500 feet, extreme breadth 100 feet, and 24½ feet on the sill at high water, ordinary spring tide.

The designs for the Quebec Harbor Improvement were prepared by Messrs. Kimpple & Morris, the well known engineers of Westminster, London, and Greenock, England, and were the result of a successful competition, in which the leading specialists on this class of work were invited to complete.

Mr. W. Pilkington, M. I. C. E., received the appointment of Resident Engineer to the Harbor Commissioners, and is in charge of the construction of these works. We hereby tender our thanks to him for his courtesy in giving us our information on this important undertaking; and at the same time we must also acknowledge the kind attention we received at the hands of Mr. Chas. Bailliarge, C. E., City Engineer of Quebec, who has promised us much information on Quebec Public Works, who also submitted a design for the harbor works, a description of which may be interesting to our readers at a future time.

The probable intention of the Harbor Improvement is to make of Quebec the great entreport of trade in Canada, and the point for exportation of grain from the western portion of the continent of North America to Europe, from its connection with the North Shore Railway on its completion to Montreal, itself a factor of the Canadian Pacific system.

DRAINAGE OF THE NORTHERN RIVERS.

ON the 8th inst. we noticed Gov. Rounds' resolution in regard to the construction of reservoirs on the headwaters of the Wisconsin, St. Croix and Chippewa rivers. The following communication to the Wisconsin *State Journal* will prove of interest in that connection:

The preamble and resolution prepared by Congressman POUND for introduction at the regular session, in relation to improving the navigation of the Upper Mississippi river, by creating reservoirs upon the heads of some of our principal streams, by no means attracts that attention in Wisconsin which its importance deserves. This doubtless arises from lack of information as to the plan and purpose of the work, and of its entire feasibility, with but slight expenditure of means. A brief article upon the subject will scarcely be deemed amiss at the present time.

The continental drainage of North America is not by regular slope, but from terrace to terrace,—well defined by falls or rapids. The upper terrace of the Mississippi is a vast lucustrine region filled with lakes so countless as to have as yet escaped even numbering. These, with their accompanying wet or marsh lands, approach with-

in a very few miles of Lake Superior, from whence they are often only separated by a mere ridge. Indeed, in places, the waters of some of these swamps flow from opposite sides to both river and lake. The area of these bodies and almost valueless low grounds in Minnesota and Wisconsin is found to cover more than 20,000 square miles of surface, all the flowage from which is concentrated in probably less than six principal rivers, of which the Mississippi is the central channel. In all cases, too, the waters flow from the upper level over sharp, rocky hedges, of very moderate width at the point of embouchure, so that dams to hold back the floods can be easily and cheaply constructed, and a surplus always be held for use when needed to render the river navigable in seasons of low water. Probably $500,000 would amply suffice for all needed structures in both States, and would insure to raftsmen and steamers a sufficient depth to float out the product of the forests and farms at all available seasons.

This project, doubtless new to most of the people of Wisconsin, is by no means so to the people of Minnesota, where it has been agitated for many years, and has had an especial zealous friend in Gov. Washburn. In this State the St. Croix, Chippewa, Wisconsin, and possibly the Black river, are the streams most important to consider in this connection. They head in a terrace which may almost be pronounced common to them all. The line of the fourth principal meridian follows a swampy region for nearly 150 miles, and this area is penetrated by so many small affluents that their names even cannot be mentioned. Yet, at favorable points, single dams on each of the principal rivers would probably create one great reservoir, in effect, which would not insure the needed annual water supply, but do much to temper the climate in more southern sections. In view of the climatic extremes in the two States, it is doubtful if this latter consideration alone would not more than repay any expense involved.

The Mississippi, in common with other western rivers, exhibits the effect of advancing improvement and civilization. The breaking of the original prairie sod enables mother earth to absorb the rains, instead of their flowing off as of yore, doubtless to the extent of one-fourth its ancient volume. Meanwhile the work of the evil, which the lessened water has no power to remove, is steadily filling, and, as it were, lifting up the bed of the stream; while its width is not as yet diminished, the depth grows yearly less, so that, unless improved, the years are few indeed in which steamers will be able to reach St. Paul, unless in seasons of flood. By the vast reservoir system, which it is now proposed to create, in sections where the evil is comparatively valueless, holding in Minnesota alone 96,500,000,000 cubic feet of water, the level would be kept at an even stage, and the compressed current made to sweep out and keep its channel in navigable order. By this system, instead of wasting millions in trifling with the shifting sands of the lower Wisconsin, a permanent supply would be stored up at the head of the stream, ready for use, whenever required to meet the wants of navigation of any kind. The same would be equally true of the Chippewa and other streams flowing westward.

Such is the simple plan of river improvement proposed by Mr. Pound. Our people want to divest themselves of the notion that Northern Wisconsin is mountainous. Except the dividing ridge, and Penoka range, it is almost a dead plane, of no very great elevation. The highest point between St. Paul and Duluth is only about 560 feet; the lowest is probably not over 350. Mackinaw boats were in early days taken across from near Ashland to the Mississippi. Lake St. Croix has only 26 feet higher level than Lake Superior. Probably the mouth of the Chippewa and the Waters of the great Lake are nearly on a plane. A navigable route across is quite as feasible as by way of the Fox and Wisconsin rivers, and as settlements push northward, will yet attract a large share of public attention. With possibly a single excepted point, the Blue Mounds have the highest summit in Wisconsin. What we most need to insure permanent river channels is a permanent supply of water, and to end the natural drainage, which is a simple alternation between floods and drouth — between a useless surplus and a deficiency. Nor should it be forgotten that every ton of water can be made to float a ton of freight, and bear it away to distant markets if we but set aside a store for use when not needed.

WING DAMS IN THE MISSISSIPPI ABOVE THE FALLS OF ST. ANTHONY.*

The Mississippi River would be navagable from the Falls of St. Anthony to Pokegema Falls 360 miles, if it were not for certain obstructions.

In the summer of 1874, $25,000 were available for the improvement of this portion of the river. Col. F. U. Farquhar, Corps of U. S. Engineers, who was charged with the expenditure of the money, decided to use it in improving the 77 miles between Minneapolis, at the Falls of St. Anthony, and St. Cloud.

The writer was in immediate charge of the work; all the plans, however, were either originated by Col. Farquhar, or submitted to him for his approval.

The Mississippi between the points mentioned, usually runs between well defined banks that are subject to erosion in but few places, the bed of the stream being generally hard pan or gravel, and there is but one place where a cut-off is possible; the average fall of the river is 1.3 feet per mile; there are however several boulder bars acting as dams, giving pools above and rapids below their crests.

The most rapid water during the low stages of the river is at Spring Rapids, full 1.5 feet in 800 or 9.9 per mile; this is surmounted by a "stern wheeler" towing a barge, by taking a run at it.

From St. Cloud to near Fort Ripley, 53 miles, the river passes through an outcrop of crystaline rocks, and will require 3 or 4 locks to render it navigable; from Fort Ripley to Grand Rapids, 3½ miles below Pokegema Falls, the river flows through an alluvial country, with flat slopes, "cut-offs," &c., and gives traffic to one steamboat that plies between Aitkin on the Northern Pacific R. R. and Grand Rapids.

Between St. Cloud and Minneapolis very little sand is carried by the river at low water, and the water is brown from the swamps and wild rice fields at its head.

Just below St, Cloud are the so called Thousand Islands, where the river is spread by a gravel bar into many channels, preventing the passage of boats at low water.

It was determined to improve this by brush dams.

The appropriation, which was not available until the middle of July, was too small in amount, and its continuance was too precarious, to justify any large expenditure for outfit—stone for the dams could not be procured for less than $2.50 per cubic yard, and all the gravel that could be procured at the outset was in the bed of the river; for these reasons there were some peculiarities in the location and construction of the dams.

Construction of Dams, Material, Organization, Outfit, &c.—The dams were built of fascines, secured by stakes, and gravel or sand, 2,735 linear feet of dams and 314 feet of bank protection were built at the point indicated, with contents as follows:

Dams	6,807 cubic yards.
Bank protection	418 " "
Total	7,225 " "

4,699 fascines were used, varying in diameter from 9 to 18 inches, and in length from 15 to 22 feet.

The average height of the dams was 3.3 feet, and 1.62 fascines were used per linear foot.

Allowing the average size of the fascines to be 16 cubic feet each, 38.5 per cent., or 2,785 cubic yards of the dams were brush and 4,440 cubic yards were gravel, which was transported an average distance of over 500 feet, mostly in wheelbarrows.

It was impossible, on account of absence at other works, to take measurements as often as necessary to arrive at correct quantities, and some of those given, depending on the writer's judgment, are liable to a ± correction.

The work was in charge of H. C. Henry, overseer, who was possessed of industry and judgment; the laborers were divided into those who worked on land at 19½ cents per hour, and those who worked in water at 26½ cents per hour.

The outfit, inplements, boats, lumber for horses and runways, spun-yarn, rope, etc., cost $763.44, and the value of material at the close of the work was estimated at $137.67, leaving $625.77 for use, which is apportioned as follows:

Making fascines, including 2,500 pounds spun and lath yarn	$379 31
Making stakes	5 40
Laying fascines	68 00
Driving stakes	50 35
Graveling dams	122 71
	$625 77

The fascines were made from willow, swamp maple black and bur oak brush, nearly all but the first being the tops and trimmings of stake timber.

Five men constituted a gang of fascine makers, 1 cutting brush, 1 cutting and carrying, and 3 at the trestles, which were of 2x4 inch pieces driven into the ground and connected at the crossing—which was about the height of one's hips—by a carriage bolt.

The levers for the "chokers" were 40 inches long, 3 inches in diameter at the ring for the chain, which was 18 inches from the short end; they were 1½ inches in diameter at the short end and 1⅛ inches at the long, and the chain was 6 feet long, which is the right length for an 18 inch fascine. When small ones were made knots were tied in the chain.

The fascines were usually tied with 5 bands of spun or lath yarn, each band consisting of 2 strands wrapt twice around the bundle and tied by the third man in a square knot; while the others bore their weight on the levers, the bundles were very compact. 4,704 fascines were made, and 5,276 hours' labor were charged to the same, which included the carriage of the fascines to the bank, or some places accessible to teams by the men at the trestles, giving about 65 minutes' labor per fascine. The best work that was noted was at the rate of 1 fascine in 49 minutes.

Brush for about 240 fascines, 15 inches in diameter, can be cut from an acre of willow as it grows on the "tow heads" and islands. I think not more than one-half of this would be cut from burr or black brush.

The cost af 4,704 fascines was as follows:

5,274 hours' labor, at 19½ cents	$1 028 82
Use of tools and spun yarn	379 31
Superintendence and overseer	387 50
	$1 795 63

or 38.2 cents each; of this 7.5 cents was for binding material 0.556 pounds having been used per fascine. If the work had been continued it was proposed to use galvanized wire for at least one dam.

The cost of making 14,280 stakes, 5 to 9 feet long was—

1,885 hours' labor, at 19½ cents	$367 58
Use of tools	5 40
Superintendence and overseer	109 50
	$482 48

or 3.4 cents per stake.

Placing and Staking Fascines:—The fascines were at first tied into mats between parallel poles and rafted into position, but with the appliances we had, it was difficult to place them satisfactorily, in consequence of the rapid current, and after 2 or 3 mats had been sunk the fascines were transported to the dams on scows and placed separately.

One row was generally placed across the bottom, parellel to the current, brush ends up stream, and staked back of the upper band. A single row of fascines was then placed lengthwise of the dam, about 3 feet up stream from the butts and staked through each bundle under it. This was advisable, because the current bent back the tips of the fascines so that the dam tended to become thickest in front. Gravel was then filled in to cover the tips of the lower row and make a plane surface to the transverse fascines. The succeeding courses were placed parallel to the current, except where the dam was unusually high, when another transverse course was placed, care being taken to have at least one course parallel to the current when the dam was finished. When the current swept the gravel off the dam as it was being built, boards about a foot wide were slid down in front of the back row of stakes, which retained the gravel until the fascines were secured on it, the intention being to have about a foot of gravel between the layers of fascines.

The courses, as usual, were stepped forward 2½ to 3 feet. In one instance, on a dry bar, a single row of fascines were laid lengthwise of the dam and a layer staked across them, with the butts overhanging about 2 feet. This plan did not prove judicious, and was abandoned.

*A Paper read before the American Society of Civil Engineers, by Edward P. North, C. E. May 11, 1877.

Stakes were driven, if possible, into the bed of the stream and to the surface of the water or dam.

On the completion of the fascine work, any projecting stakes were cut off nearly flush with the surface of the dam, so that they should not be loosened by logs striking them. All was then covered with a coating of gravel carried horizontally about 6 feet up the stream. It was intended to give the fascines such an inclination that the depth of gravel would be fully a foot at this point, to protect the dam from the impact of logs (of which 225,000,000 feet B. M. were floated down the river during 1874), also to guard against the fascines being torn out in high water, by the buoyant effect of the ice frozen to their butts.

The cost of placing and staking 4,699 fascines was;

4,290 hours' labor, at 26½ cents	$1 136 85
507 hours' team work hauling fascines, at 40 cents	202 80
Use of tools, laying fascines	68 00
" " driving stakes	50 35
Superintendence and overseer	529 36
Total	$1 987 36

About 65 per cent. of the above labor and superintendence was probably expended in driving stakes.

Gravel.—Very little of this would have been stopped by a 2½ inch ring; 40 or 45 per cent. was sand and the rest gravel, in the usual acceptation of the term.

When the operations were commenced, gravel could not be obtained from the banks, and dam No. 1 was so located as to leave as much of the bar below it available for its construction as possible. Dam No. 2 was also given its curved outline, partly for the gravel and partly for economy in construction.

Before No. 2 was completed, permission was obtained to take gravel from the bank opposite the head of Island 126, which was taken over the channel on runs supported by horses.

Dams 3 and 4 were built almost entirely of fine river sand, covered and faced with gravel brought on scows. Dams 5 and 6 were built with gravel laid dry by themselves and Dam No. 1, which was brought on scows and run-ways.

Cost of 4,440 Cubic Yards of Gravel:

Loading, wheeling etc., with care of runs on ground, 11,727 hours, at 12½ cents	$2 286 76
Setting and maintaining runways over water, 428 hours, at 26½ cents	113 42
Use of tools, etc.	122 71
Superintendence and overseer	743 22
Total	$3 266 11

or 75 $\frac{8}{10}$ cents per cubic yard.

Total cost.—As stated above, there were 2,735 feet of dam and 314 of bank protection. As 1.88 feet of bank protection was equal to 1 foot of dam in contents, the length of dam may be called 2,990 lineal feet, and the quantity 7,225 cubic yards. The cost was found to be as follows:

Making fascines	$1 795 63
" stakes	482 48
Placing fascines	695 59
Staking "	1 291 77
Gravel	3 266 11
Total	$7 531 58

Cost per lineal foot, $2.60; cost per cubic yard, $1.05.

About 34 per cent. of the cost was for gravel, and 24 per cent., or $1,775, for stakes and driving them.

This would have bought 710 cubic yards of rock; about twice that amount would have been required to anchor the brush, and it is doubtful if the dams would be as tight as at present.

Stone laid on the faces of the dams would be picked up by the ice and carried down stream. A more expensive outfit would also have been required to control the mats in the current until they were anchored. On the other hand, the quantity of gravel used would have been reduced.

The only dams with which I am sufficiently familiar to institute a comparison, are those built under the direction of Col. Houston by John Nader and his successors, which are proving so efficient in controlling and deepening the channel of the Wisconsin.

In the report of the Chief of U. S. Engineers for 1872 (page 132 *et seq.*), Mr. Nader returns the cost of 10,679 feet of dam "not including stationery, mileage, tools, boats, or general repairs of tools, boats, or implements," as $41,022,06, or $3.81 per lineal foot. Of this, $11,590.36 is charged as materials, probably brush and stone, which would reduce the cost of building to $2.76 per foot. No estimate is made of the cost per cubic yard.

The system adopted on the Wisconsin, is the use of fascines 10 inches in diameter and 12 feet long, tied by 3 wythes, which are made into mats, sunk and anchored by the use of stone.

The estimated cost for 1876 is $3.50 per foot, but no statement of cost has been made public since 1872.

The price of the Mississippi river dams, $2.60, not only included all of the above items (excepting stationery), excluded by Mr. Nader, but also contained the cost of a preliminary survey. It is possible that the use of stakes instead of rocks may often be economical, notwithstanding the rather heavy cost of driving them.

The dams at St. Cloud were intended to increase the depth of water on bars near Islands 126 and 129, and to protect a sand bluff behind 137, which contributed a great deal of sand to the river in high water.

On the completion of the last dam there were about 3 feet of water on the bar at the head of Island 126, and an average gain of over 1 foot below that, which improvement was thought due to both erosion and the increased amount of water in the channel, there being a decided back-water from dam No. 2 to above the lower landing.

The dams were left about a foot above low water, as it was not thought that the river carried sand enough to fill the channel during high water, and it was desirable to present as little obstruction to log driving as possible.

No attempt was made to use the whole volume of the river, as the water naturally flowing by the lower landing was thought sufficient to make a 3 or 3½ foot channel; the amount of water, however, can be readily increased by dams near Island 109.

The locality was visited in the latter part of December, after the river had frozen. Dams Nos. 1 and 2 were in many places covered with thick ice, which extended over the rear of the dams, enveloping the butts of the fascines; the dams were unexpectedly tight, only one leak in the first and three small ones in the second were observed, and there had been a decided shoaling in front of the concave part of No. 2; the other dams were so thoroughly covered with ice that not much could be seen of them.

The winter of 1874 and '5 was a severe one; at St. Paul the thermometer ranged for about twenty mornings between 0° and —39° Fahr. Ice in the river was 3 feet and in some instances 4 feet thick. Mr. Henry was at the dams shortly after the break-up, and learned that the ice first followed the channel to dam No. 1, on which it gorged; the ice then broke over Nos. 2 and 5, passing behind Island 137, cutting a good deal of sand from the bluff. None of the dams showed any injury, except that the butt of the upper fascine in Dam No. 4, which was mainly built with sand, had been lifted and bent over by the ice; this was very satisfactory, as no crib dam had stood on the river from the Falls of St. Anthony up.

If the improvement of the river is ever undertaken, with a prospect of continuous appropriations, it will probably be best to place a sufficient number of light dams in the channel back of Island 137, to warp it full and then plant willows on the bar so formed, as the bluff is the worst reservoir of sand on that portion of the river.

An attempt was made to close the cut-off below Clear-Water. The water here was from 10 to 12 feet deep and the current very strong. Stakes or light piles were driven by hand from a boat, in pairs about 10 feet apart; horizontal pieces were spiked to the stakes, and poles lashed to them, on which fascines were placed and loaded with gravel (the horizontal pieces carrying the run-planks for the wheelbarrows); the lashings were cut simultaneously and the mat allowed to sink; this was repeated till the dam was brought to the surface of the water. The increasing cold and a rise in the river flooding our gravel pits, compelled the abandonment of the work before it was secured. It was intended to sink an apron of mats at the rear of the dam, which was nearly vertical, and shingle mats down the face. The next year, the river men cut through the bend at the end of the dam, to save driving their logs around the bank, which was sufficient to wreck the affair completely, and the main channel of the river now follows the cut-off.

Since writing the above, Col. Farquhar writes to me that on April 15th, an inspection of the dams was made by J. L. Gillespie, Assistant Engineer, who reports in substance as follows:

Dam No. 1 has three breaches in it of an aggregate length of 73 feet. Dam No. 2 has a breach about 30 feet wide opposite the upper point of Island No. 126; the rest of the dam is uninjured and tight; that portion between Islands 112 and 123 being well covered with sand and small willow brush growing upon it. The upper layer of fascines for nearly the whole length of Dam No. 4 seems to have been torn off, leaving the stakes about a foot higher than the dam. There is also a breach 35 feet wide at the head of Island 137. Dams Nos. 3 and 5 are in good condition, with a sand bar 10 to 40 feet wide behind No. 5. Mr. Gillespie adds "as there has been no high water or heavy ice since the last inspection, it is probable that all the breaches above described were made by log drivers during the past summer and fall." Col. Farquhar remarks "they have stood splendidly and would be as good to-day as when they were put in, had it not been for the vandalism of the log drivers who made the cuts through them."

It will be remembered that Dams Nos. 3 and 4 were built of fine sand, covered and faced with gravel; the gravel in Dam No. 1 was as coarse, if not coarser than in any other.

WATER FOR FIRE EXTINGUISHMENT.

Several months ago the Metropolitan Board of Works, of London, Eng., directed Sir Joseph Bazalgette, in conjunction with Messrs. Bramwell and Easton, to carry out a series of practical experiments upon the question of fire jets, which should put beyond all doubt the engineering points involved. The result of these experiments is recapitulated as follows in a paper prepared by the last two engineers, and recently read before the British Association at Plymouth:

With a very low jet, say of some 30 feet, about seven-eighths of the head or pressure effective at the orifice of the jet will be obtained, as the height of the column of water—that is to say, 40 feet of head at the orifice would give a jet of about 35 feet in perfectly still air; but as the heights of jets are increased, and increased they must be, if they are to be of any service in extinguishing fires in modern buildings, which are so lofty, the percentage which the column of water produced bears to the effective pressure producing it becomes less and less, so that for a jet to rise to the height of 80 feet there must be, roundly, a pressure equal to 128 feet. To rise a height of 100 feet there must be an effective pressure of about 180 feet. Moreover, the higher the jet the greater must be the diameter of the column of water.

The following is a fair average jet required for London purposes: A jet that would rise 80 feet in still air, if of 1 inch in diameter, would deliver the 150 gallons per minute, and would demand an effective pressure, as has already been said, of 128 feet at the very orifice of the jet; and it might be thought, therefore, that if a pressure could be maintained in the pipes equal to 128 feet of head, when the water was flowing, that all that was desired would be provided. But this is not so. There is the very striking, and to many people very unexpected, consideration of the friction of the water through the hose to be taken into account; and the section may, perhaps, little expect to be told that every foot of the usual size of hose employed by the London Fire Brigade, when conveying 150 gallons of water per minute, requires a pressure of a little over three inches to drive that water through. As a matter of fact, the 200 feet of hose demands 53 feet of pressure to get 150 gallons per minute through them. Therefore, to obtain a jet of 80 feet high, expending 150 gallons per minute at the end of 250 feet of hose, there is needed a pressure of 181 feet, and this pressure must be maintained while the water is flowing.

M. Gartiaux has published some curious statistics on the dangers of traveling by land. He says that in the old diligence days, a man had one chance of being killed in 300,000 trips, and one chance of being injured in 30,000. On the railway, between 1835 and 1855, there was one chance of being killed in 2,000,000 journeys, and one chance of being injured in 500,000. From 1855 to 1875 one chance of being killed in making 6,000,000 journeys, and one chance of being injured in 500,000. Now, one to 1,000,000. Consequently a person traveling 10 hours a day, at the rate of 40 miles an hour, would, in the first period, have had a chance of escaping destruction during 321 years; in the second period, during 1,014 years; and between 1872 and 1875 during 7,439 years.

WROUGHT IRON GIRDER WORK.*

BY C. GRAHAM SMITH.

President of the Liverpool Engineering Society, Associate of the Institution of Civil Engineers.

ADDENDA.—SPECIFICATIONS CONTINUED.

Concluded from page 357.

*Paper read before the Liverpool Engineering Society, June 20, 1877.

Description of Rivet.	Friction per Rivet.		
	1st Experiment.	2d Experiment.	Mean.
	Tons.	Tons.	Tons.
Snap-heads and points	5.14	4.21	4.67
Pan-heads and conical points	5.26	4.81	5.00
Countersunk heads and points	4.56	3.74	4.15
Mean of the three	..	..	4.61

The second set of experiments was made with plates 11in. wide and ⅜in. thick, the rivets used being 1in. diameter. The following results were obtained under the above-stated conditions of pitch of rivets, lap, etc. :—

Description of Rivet.	Friction per Rivet.		
	1st Experiment.	2d Experiment.	Mean.
	Tons.	Tons.	Tons.
Snap-heads and points	5.84	5.61	5.7
Pan-heads and conical points	6.87	7.24	7.0
Cuntersunk heads and points	4.56	4.09	4.3
Mean of the three	..	..	5.6

"In addition to these experiments with iron plates and rivets, two other sets of experiments were made with steel plates and rivets of exactly the same dimensions as those used in the former experiments, the pitch of rivets, breadth of lap, etc., being in each case identical with those previously given. With ½in. plates and ¾in. rivets, the results obtained were as follows :—

Description of Rivet.	Friction per Rivet.		
	1st Experiment.	2d Experiment.	Mean.
	Tons.	Tons.	Tons.
Snap-heads and points	3.86	4.09	3.98
Pan-heads and conical points	4.79	4.79	4.79
Countersunk heads and points	3.63	3.43	3.53
Mean of the three	..	..	4.1

"With ⅞in. plates and 1in. rivets, the following results were obtained :—

Description of Rivet.	Friction per Rivet.		
	1st Experiment.	2d Experiment.	Mean.
	Tons.	Tons.	Tons.
Snap-heads and points	6.43	5.9	5.96
Pan-head and conical points	5.49	None made.	5.49
Countersunk heads and points	5.14	4.91	5.02
Mean of the three	..	..	5.49

"It thus appears that rivets with pan-heads and conical points have the advantage over both the other descriptions of rivetting. The only exception to this is found in the second set of the experiments with steel plates and rivets ; but as only one experiment was made the result cannot be relied on. It also becomes evident that counter-sunk rivetting causes much less friction than the other systems. On comparison it will be seen that in nearly all cases steel plates and rivets give less friction than iron, the only exception being the cause of rivets with snap-heads and points, and those with counter-sunk heads and points, in the second set of experiments. The former of these exceptions is scarcely worth notice, as the difference is so small. The use of larger rivets with the same pitch, etc., gives an increase in the friction, but no law of increase appears to be conformed to."

"Although these experiments do not give any definite idea of the probable amount of friction which would result from the use of rivets having different diameters and pitch, they yet serve to show how much the strength of a rivetted joint is increased by the contraction of the rivets."

Mr. Reed, at a more advanced stage of his investigation on this point, says :

"It would consequently be improper to arrange the fastenings of a wrought-iron structure on the assumption that the shearing strength of the rivets (determined by experiments on rivet bars), and the friction of the surfaces, might be treated as acting conjointly but independently. In the investigations on rivetted work which are given in this chapter we shall, therefore, assume that friction is included in the values which are employed for the shearing strength of the rivets."

Mr. Reed considers that his views as here expressed agree with those of Mr. Fairbairn before given. Still the author thinks that there is some disparity in the views held by the eminent authorities named. If this were not so, he would certainly hesitate to express the opinion that, unless in very superior work, rules in regard to the friction between the plates deducted from experiments, will prove very fallacious in practice. Rivets frequently not only do not fill the holes, but they are in addition sometimes positively loose. Under any circumstances it may safely be assumed that there are few rivets in any work which exert a holding-together strain of 24 tons per square inch. Even should such be the case on the completion of the construction of the work it would not be of long duration. A very small additional strain will cause iron to considerably elongate, when previously under a strain nearly approaching its breaking point ; and the smallest possible additional set will be sufficient to do away with any advantages to be obtained by the contraction of a rivet in cooling. Although it is not here the intention to imply that the frictional resistance of the plates will not add a certain amount of strength to a joint, still the author is of opinion that with vibration any additional strength caused by this resistance will be destroyed, and that therefore the old rule should be adhered to of making the shearing area of the rivets on one side of the butt equal to the effective area of the plates in tension. The shearing strength of a rivet not being equal to the bar from which it is made, a few rivets over and above the number thus deducted will in the author's opinion neither do any harm nor add greatly to the cost of the structure.

While on this question it may be well to touch briefly upon the kindred subject of cast iron. The proper design and relative proportions of the flanges of an ordinary cast iron girder have been repeatedly subject to experimental investigation. The results obtained are so familiar to every engineering student, being given in full in most engineering work of a compendium nature, that it will here suffice to remark that opinions differ as to the relative areas of the top and bottom flanges. There are, nevertheless only a few engineers and scientific men who will argue that the area of the top flange need be greater than one-fourth of that of the bottom flange, and as this is the proportion employed in many large works recently constructed by our leading engineers, the author feels that he will not err if he advocate the adoption of this ratio in future practice. Having arrived at the relative areas of the flanges, the next question is to decide upon the proper area of the bottom flange. With a dead load cast iron may be subjected in actual working to a tensile strain of 1½ tons per square inch, but with a live load it is advisable not to exceed a calculated strain of 1¼ tons per square inch. The strain on the flanges having been calculated they may now be designed, and so formed as to suit themselves to outside considerations as well as exigencies of a practical nature. In designing the top flange, with a view of adding to its lateral stiffness, it should be made as wide as the amount of metal in it will allow, of course bearing in mind that a certain minimum thickness is required for foundry operations. Where the girders support jack arches and are concreted over the top, or in fact in any position in which lateral movement of the girder is impossible, width of flange is not necessary. [When dealing with a girder continuous over its supports the top flange will be in tension over three points, and consequently matters in this case will be entirely reserved.] The web now alone remains to be considered. Its dimensions are governed entirely by considerations of a purely practical nature. If only made of sufficient thickness to resist the strains brought upon it, it could not be cast owing to the small proportion which its mass would bear to that of the flanges. If the thickness of the web at the top be made the same as that of the top flange, and gradually increased downwards to about the same thickness as the bottom flange, and the remarks which have been previously made regarding the area and design of the flanges be borne in mind, the resulting section will, in the author's opinion, meet constructional requirements and the wishes of the iron founder.

It is at once evident that before an engineer is qualified to design cast iron work he should to some extent be familiar with the details of both pattern making and moulding. Without such qualifications he is apt to make his castings expensive, and the author has even seen designs sent out which defied the skill of an ordinary foreman moulder simply through the man who made them not knowing how "boxes" and "cores" are manipulated. It should also be remembered that small masses of iron cool more quickly than large masses, and that therefore portions of small dimensions will consolidate while the adjacent portions of larger dimensions remain in a fluid state. This irregularity in cooling will produce initial strains on the iron which may distort or even cause the destruction of the casting. Care should therefore be taken both in making the designs and in making the castings in the foundry to insure the iron cooling as evenly as possible. Unless in the case of absolute fracture or much distortion initial strains give no visible sign of their existence, and are therefore all the more dangerous.

When referring to the tensile strains to be imposed per square inch of section, it was of course inferred that proper precautions would be taken to secure a good ordinary quality of iron. For structural purposes the iron should be melted at least twice, that is, the castings should not be run direct from the blast furnace. Various mixtures of iron produce different results, and the remark made in the paper that it is not wise to restrict the iron master in his process of manufaturing wrought iron also applies in this instance. It is better to specify that the iron shall stand certain tests, and allow him to make what mixtures and proceed in any way he may think proper, providing he make the desired quality of iron. One or two bars 3ft. 6in. by 2in. by 1in. should be run each day with the castings, that is, they should form part of one of the actual castings and be detached after the casting is cool. With good ordinary iron such as should be used in construction, a bar of the above dimensions when placed on edge on 3ft. bearings should stand 28 cwt. to 30 cwt. applied at the centre, and give a deflection of at least $\frac{5}{10}$ of an inch before breaking. Large castings will not be equal in quality to the test bar cast with them on account of the thickness of the various portions. For this reason it is advisable in addition to breaking the test bar to apply a proof load to all large castings designed to resist heavy strains.

The cast iron of the sleepers for the Great Indian Peninsular Railway had to undergo tests very similar to this. In addition the sleepers had to stand a weight of 3¾ cwt. falling a height of 5ft. 6in., having previously been subjected to blows from this weight falling 2ft., 2ft. 6in., 3ft., etc., up to 5ft. 6in., being at the time of testing on sand not more than 24in. deep. The average height required to break the sleepers was 7ft. 9in. The cast iron was also to stand a tensile strain of 11½ tons per square inch, and the average was 13.07 tons.

This is undoubtedly a higher strain than most cast iron used in construction in this country will be found to stand, still by proper treatment, care, and an expenditure of money it may be much exceeded. The careful experiments carried out by the United States Government, and recorded by Major Wade, of their Ordnance Board, in a volume entitled "Report of Experiments on the Strength and other Properties of Metal for Cannon, etc.," give the maximum tensile strain obtained with cannon iron at 20.5 tons per square inch; and the mean of samples cut from one hundred guns was 14.9 tons. These high results are obtained by remelting the iron, sometimes three or four times, and keeping it at each melting in a state of fusion for from one to four hours. As an instance of what may be effected in this way, samples cut from twenty-seven guns sustained a tensile strain of 15.75 tons per square inch; whilst the crude pig iron from which these guns were cast only stood 5.66 tons per square inch. More detailed information concerning these experiments may be found in a paper on "American Iron Bridges," read by Mr. Zerah Colburn at the Institution of Civil Engineers, May 5, 1863. In the discussion which ensued on that paper, Mr. Bramwell gave some interesting particulars of similar experiments.

"He (Mr. Bramwell) exhibited two samples of Acadian cold blast iron, the produce of Nova Scotia, which had been broken in his presence by the proving machine at Woolwich Arsenal. Being No. 1 iron a mixture of scrap was required before strength could be obtained. But as the experiments were made to test the quality of this individual iron, it would have rendered those experiments nugatory had scrap from any other source been mixed with the iron. The only way of proceeding that occurred to him was to melt some of the iron into pigs to make scrap the second melting, reserving trial bars of the first melting. The order of the experiments was as follows: The iron was put into an air furnace, and as soon as it was fused eight sample bars were cast. These bore an average tensile strain of 7½ tons per square inch of section. The iron was kept in fusion, and two hours after, eight other bars were cast. These did not break until a strain of eight tons 6 cwt. was attained, being nearly one ton more per square inch than the strain which broke the first lot of bars. After a further interval of one hour and three-quarters, eight other bars were cast, which broke with a strain of 10.8 tons; so that by keeping the metal in fusion for three hours and three-quarters, the tensile strength was increased from 7 tons 10 cwt. to 10.8 tons, or about 50 per cent. The iron was then poured out and pigs were cast from it. On the next occasion the furnace was charged with half of the fresh No. 1 iron, and half of the pig iron from the prolonged fusion. The result was that the bars cast immediately upon melting required for their fracture a tensile strain of 11 tons."

Bars which were cast after four hours' fusion stood an average tensile strain of 18.5 tons, and the maximum of these samples stood as much as 19.6 tons.

ELECTRIC CANDLE.

[Translation.]

SYNDICAT D'ETUDES D'ECLAIRAGE ELECTRIQUE. Jablochkoff process. Director L. Denayrouze, 61 Avenue de Villiers, Paris. Price current. Illumination by means of the Electric Candle of Works, Manufactories, Railroad Stations Docks, Open-Air Works, Markets, Theatres, Concert Halls, Large Cafés, Hotels, Restaurants, Large Stores, Museums, Churches, Palaces, Public Buildings, etc.

The Jablochkoff candles can give either a single powerful focus, or a series of divided foci (one per candle) among which the total illuminating power furnished by the electric current is distributed.

It is evident that the cost of candles is less as the number of foci diminishes. Nevertheless we advise consumers to divide the light as much as possible. There is no doubt about this for establishments at all luxurious; but even for works and all sorts of manufactories, where the light may be less distributed, we recommend the simultaneous use of at least two foci.

The Jablochkoff candles are about 30 centimetres (11 8–10 in.) long, including the brass sockets.

Not less than 100 candles are sold at a time.

Prices of the Jablochkoff candle:

Diam. of carbon of candle.	Price per candle.	Method of employing magnetic machine.	
		With three discs.	With four discs.
metres.	francs.		
0.004	0.75	for 3 luminous foci.	for 4 luminous foci.
0.005	1.00	for 2 luminous foci.	for 3 luminous foci.
0.006	1.25	" " "	for 2 luminous foci.

Remarks.—The ends of burned candles will be taken back at the rate of 10 francs per thousand, delivered free of charge.

Accessories.—Magneto electric machines with alternating currents:

1. With 4 disks	7000	francs.
2. With 3 disks	6000	"
Wrapping of hystasape cloth, to protect the wrapping machine from dust	50	"
Packing cases for the magnets and "rouleau"	100	"
Conductor 0.005 m. diameter of annealed rose-copper wire, with double insulating envelope of caoutchouc and lined, per metre	2.50	"
Do. Do. of 0.006 m. diam	2.75	"
Commutators—3 directions	30	"
Do. 2 do.	25	"
Windlass with ratchet for raising and lowering the luminous foci	50	"
Chandelier for one candle (candlestick)	20	"
Wire holder ("serre-fils") each	0.25	"
Carbon handle for lighting	1	"
With one metre for carbon 6 millimeters in diameter	2	"

Important Notice.—An estimate will be sent to all persons applying to the director of the "Syndicat d'Etudes d'Eclairage Electrique, 61 Avenue d'Villiers, Paris.

The application must be accompanied by:

(1.) A drawing with dimensions, giving a plan of the place to be lighted, their height, position of motor, of the transmissions, and of the columns supporting the brackets. (2) The kind of motor and the number of horse power which can be transmitted by the main shaft. (3) The forms of ceilings, their nature (glazed or not), their color. (4) The various unoccupied spaces where the magneto-electric machines can be placed. (5) The number of gas-burners, oil or petroleum lamps actually employed for the illumination, with an estimate of the quantity of light produced.

Notice.—The prices are cash and net. The costs of transportation are paid by the buyer. The prices are for the apparatus taken at the works.

A pamphlet giving all necessary information in regard to the use of the Jablochkoff candle, the setting up and taking apart of the magneto-electric machine, accompanies the present price current.

A prospectus containing a brief account of the discoveries of Mr. Jablochkoff and their application will be furnished to all those who apply for it.

Example of an estimate for a complete installation giving a really utilized intensity of 150 carcel burners for two foci:

Alliance magneto-electric machine with alternating currents, type with 3 disks	6000	francs.
100 meters of conductor of annealed rose-copper wire, 0.005m. in diameter, insulated by a double envelope of linen and caoutchouc	250	"
A commutator for two directions	25	"
Six wire holders ("serre-fils")	3	"
Two ordinary chandeliers	40	"
Total	6318	francs.

Rough estimate of the corresponding cost of consumption in the most unfavorable case, that of a special motor:

Fuel for motor (2 horse power)	0.24	francs.
Wages of fireman	0.50	"
Candle (2 candles burning 1½ hours at one frame each or for 2 hours)	0.80	"
Total expenditure	1.54	francs.

Example of estimate for a complete installation, giving a really utilized intensity of 200 carcel burners for 4 foci:

Magneto-electric machine with alternating currents, type with 4 disks	7000	francs.
190 meters of conductor of annealed rose-copper wire 0.005 m. in diameter, insulated with a double envelope of linen and caoutchouc	250	"
One commutator for two directions	25	"
Six wire holders	3	"
Four ordinary chandeliers	80	"
Total	7358	francs.

Rough estimate of the corresponding cost of consumption in the most unfavorable case, that of a special motor:

Fuel for motor (2½ horse power)	0.30	francs.
Wages of fireman	0.50	"
Candle (4 candles of 2 hrs., at 0 fr., 75 cent., or per hour)	1.50	"
Total expenditure	2.30	francs.

Remark.—If the illumination has to last more than three hours without interruption, the multiplying chandeliers are employed, permitting the automatic replacement of several candles in succession.

Price of chandelier for 2 candles	50	francs
Price of chandelier for 3 candles	70	"
Price of chandelier for 4 candles	80	"
Price of chandelier for 6 candles	100	"

These prices of chandeliers are those for industrial illumination. For an illumination of luxurious establishments a detailed and special estimate will be made for the apparatus.—*Iron Age.*

WEISBACH'S FOMULÆ.

Referring to Philadelphia correspondence on page 234 ENGINEERING NEWS, (current volume), the following, in answer to a part thereof, was mislaid, but is not too late for insertion:

Square the equation given by your correspondent as the correct one; and

$$v^2 = \frac{64.38 \times v}{1.505 + \frac{c\,v\,i}{d}}$$

Divide by v and we have

$$v = \frac{64.38}{1.505 + \frac{c\,v\,i}{d}}$$

The gentleman's complaint is groundless.—E. C.

LIVERPOOL ENGINEERING SOCIETY.

On Wednesday evening the 5th inst. this Society held its usual meeting at the Royal Institution, the chair being taken by the President, C. Graham Smith A. I. C. E. A paper on "Stone in Engineering" was read by Mr. F. C. Pembroke Jones—In dealing with granites he compared them as regards their color, weight, and durability under various circumstances, and showed by the result of experiments that although "Aberdeen" has three times the wear in it for road making that "Guernsey" has, it possesses a very little additional resistance to a direct crushing force. He then described the various methods of quarrying and transporting granite blocks. The various qualities of slates were discussed, and it was pointed out that the common or clay slate, which is invariably stratified, is one of the most useful in constructive operations on account of its laminar texture. The best sandstone on an average contain nearly 96 per cent of silica, and their durability much depends upon the nature of the substance with which the grains of sand are cemented together. Among the limestones he said the oolites contained 90 to 95 per cent of carbonate of lime. He described the Plymouth limestone as hard and fine grained and varying in color from a light to a dark gray. He completed his valuable paper by briefly considering the strains to which stones are subject in constructions of an ordinary nature, and mentioned the various ways in which stones of the different classes are supposed to decay.

One of the largest orders which has been given in this country for surveying instruments was recently given by Columbia College, of New York city, to the well known manufacturers, Messrs. Heller & Brightly, of Philadelphia. The first installment of this order, consisting of eight combined transit and leveling instruments, four Y levels, and four plane-tables, has been delivered. The requirements of the School of Mines, under the "new departure" inaugurated by Professors Towbridge and Monroe, it is expected, will call for over three dozen transits, levels, and plane tables. The exact number of instruments will be 38, and cost to the College is $8,600.

The new line of steamers between New York and Venezuela has gone into operation.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER-WORKS.

London, Ontario, passed the water works by-law by a majority of 147, last week.

The engines and pipes for the new Pawtucket (R. I.) water works are being made in Chicago.

Keokuk hopes to have its water works completed by May 1st next. The engine house foundations will be built, the filter-bed made, and the inlet pipe laid this winter. Mr. Truman Cowell of Muscatine is one of the contractors.

The engines of the new Detroit water works were put into motion on the 15th inst. The Detroit *Post* and *Tribune* of that date improves the opportunity to give an interesting history of water works in Detroit from their earliest inception. The engines of the new works were built by the Detroit Locomotive Works, and cost $104.449. The receiving basin and canal were constructed by Wattou, Lacy & Walker for $109,000. The slate and iron roofs are the work of the Detroit Bridge & Iron Works.

The Indian Ford dam, a short distance from Fort Atkinson, Wis., has lately been raised for the purpose of giving Lake Koshkonong reservoir capacity to supply the numerous manufacturing villages on Rock river during low water. The land-holders claim that 20,000 acres of meadow land worth $30 per acre will be overflowed. Some have threatened to raise a mob and remove the dam. In the meantime the County Board has met to take action in the premises.

The citizens of Council Bluffs, Iowa, are discussing the subject of water works. Recently a Boston firm, S. L. Wilding & Co., have proposed to supply the city with "pure Missouri river water" at a cost of $130,000 to $150,000, provided the city will grant them certain exclusive privileges;—$100 to be paid for the first 100 hydrants annually; one new hydrant established for each 400 feet of main laid, the hydrants to be paid for on a graduated scale as $75 for 150 and $60 for 300, etc.; the water to be pumped into a reservoir on the bluff 250 feet high. The corporation seems opposed to granting exclusive privileges to outside parties, and will probably construct the works in due time.

RAILROADS.

Eureka, Cal., is agitating a narrow-gauge railway to Eel-river Valley.

It is proposed to build a railroad from Orange Lake to San Mateo, Florida; distance 30 miles.

A prismoidal railway is proposed, five miles in length, from Point Arena to Garcia, Cal.

The North Shore railway is entirely completed between Three Rivers and Quebec city.

Ths project of building a railroad from New York to Chicago by way of Pittsburgh is again agitated.

The Ohio River Railway Company, has been incorporated to build a road from Portsmouth to Gallipolis, $1,500,000 capital.

Six hundred miles of ties are on the ground of the Southern Pacific Railroad Company, extending from Yuma toward the Atlantic states.

The people of Belton, Texas, are said to have determined to build a narrow-gauge road from that place easterly about 50 miles to Hearne.

A meeting of the citizens of Zanesville, Ohio, was held on the 13th inst. to consider the proposition of a narrow-gauge railroad from that city to Pomeroy.

The Reading Railroad company has ordered all the stoves to be taken from their passenger cars and their places to be supplied with furnaces uuder the cars.

The New Orleans *Times* don't want the representatives of Louisiana to support any Texas Pacific bill unless the New Orleans Pacific to Marshall is inclosed in its provisions.

The Stillwater Valley Railroad is incorporated and subscription books will be opened along the line in January. The proposed road is narrow-gauge and will extend from Dayton to Versailles, Ohio.

The citizens of Burnet county, Wis., are making efforts for a narrow gauge railway from some point of the St. Paul & Duluth road to some point on the North Wisconsin.

The surveying party of the Quincy, Missouri & Pacific Railroad have reached the Chariton river, six miles west of Kirksville, and the contract for grading that section will be soon let.

It is reported that the government of Columbia, S. A., has made a contract for $20,000,000 with an Englishman for the construction of the Central railroad. Panama, it is asserted, has promised a subsidy of $250,000 per annum.

The Columbus & Northwestern Railway company, Ohio, filed papers with the Secretary of State extending the line from Columbus through the counties of Franklin, Fairfield, Hocking, Perry and Morgan, to McConnelsville, in Morgan county.

The Northern Pacific Railroad Company has completed the branch road from New Tacoma to the Puyallap coal mines, a distance of 31 miles. Regular trains are now running between these points, and large quantities of coal are being taken down to tide water. The railroad company is expending a large sum of money in the development of these mines, which promise to be the most extensive and profitable on the coast.

The difficulties in regard to the Gulf, Colorado & Santa Fe Railway have been settled and the new Board of directors hope to push construction to Brenham, Texas, next fall. Galveston county will pay over the remainder of the subsidy, viz: $50,000.

The Syracuse, Geneva & Corning railway, from Geneva to Corning, N. Y., was completed for the passage of trains on the 10th inst. This road is intended to tap the coal regions and render the New York Central and Hudson River independent of rival routes in the matter of fuel.

A new underground railway in London between Piccadilly and Shoreditch, is proposed. It is to run by way of Bloomsbury under several new streets. Another road is to run between Chelsea and Fulham connecting the latter section with the metropolitan and district railways.

The St. Lawrence Junction R. R. from Three Rivers P. Q. to Phillipsburgh, on the Central Vermont, a distance of 100 miles is now under construction, 30 miles of the southern end being already completed. The road is favorably located as to grades and alignment. It passes through a fertile country and fine timber lands. Burlington, Vt., will realy be its terminus for the timber traffic. The government of Quebec has granted a subsidy of $400,000. The road will be completed at $12,000 per mile.

A new project has been started in Iowa, and a company organized known as the Chicago, Bellevue, Cascade & Western Road which is to run from Bellevue, in Jackson county, to cascade. Monticello, through the northern portion of Jones, Linn, and Benton counties, to connect with the Farmers' Union Road, running east from Marshalltown, of which latter twenty miles are in operation: twenty more graded and the whole surveyed to Monticello. It is now quite certain the road will be completed within a year, which will give a through direct route from Sioux City to Chicago without breaking bulk or change of cars.

The construction of the Greenville, Columbus and Burningham R. R. (narrow gauge) is about to be commenced. The contract from Greenville, Miss., to Deer Creek a distance of 10 miles, has been given to the G. C. & B. R. R. Construction Company, C. P. Huntington, President, H. T. Irish, Secretary and Treasurer, land T. S. Anderson Chief Engineer. Mr. Huntington has purchased the iron for that distance in Indianapolis, and the rolling stock in Chicago. Two shipments of the iron (35 lbs. to the yard) has been received at Greenville, the balance of the iron and the rolling stock will be delivered in the next ten days, and it is proposed to have the road in running order in 60 days. The grading and some of the bridging for the first thirteen miles is already done. After reaching Deer Creek the main line will very likely be abandoned, until the Rolling Fork branch is completed. The distance from the Deer Crossing down to Rolling Fork is about 37 miles, the grading for this distance will all be embankment, but little more than surface grade, and there will be no bridges or water ways of any kind larger than 8 feet log drains or culverts.

MISCELLANEOUS.

A dam is to be built on the Fox river, near Aurora.

Superior petroleum has been struck in the Black Hills.

The telephone has been used under the straits of Dover from France to England.

Major Farquhar estimates the complete improvement of the Red river of the North at $422,000.

The Dominion government is being petitioned for a harbor of refuge on the north shore of Lake Erie somewhere in Pigeon Bay.

Mayor Ely, of New York, has appointed a Committee of Street Railroad Presidents to act with him, in consultation with the Police Commissioners, to devise means for keeping the streets and avenues clear of snow during the winter.

Creosoted piles taken from the G. C. & S. F. railway bridge across West Bay, Galveston, are found uninjured by the teredo after two and a half years. The superintendent of the road is sanguine that they will last 50 years.

Some one who assumes to know says twenty thousand oil wells have been sunk in Pennsylvania and Virginia at an aggregate cost of $193.000,000. The yield has reached 88,000,000 barrels, valued at the wells at $500,000,000, or $400,000,000 at the seaboard.

The co-operating principle is reviving in Pennsylvania. In Pittsburgh it is proposed to erect an iron mill requiring a capital stock of $1,000,000. It is to consist of one dollar shares, no one is to own over five shares and every workman in the mill is to be a stock holder.

The Louisville Bridge & Iron Co. gave notice on the 15th inst. to the Tennessee river men that during the erection of the channel span of the Cincinnati Southern Railway bridge, eight miles above Chattanooga, that passage would be closed to navigation. The draw passages each 120 feet wide can be used.

The city of Antwerp has completed the fitting of the necessary apparatus for lighting by electricity the harbor, the mouth, and part of the course of the river Eslant. The canal of the Marne to the Rhine is lighted by the same means, and to the great satisfaction of the sugar-houses there on the banks.

The Rio Grande river is navigable for steamers to Camargo, five hundred miles from the Gulf; the Trinity two hundred and fifty miles; the Neches and Angelina two hundred miles each; the Sabine over two hundred miles. The Brazos river is navigable for about one hundred miles, and could be opened several hundred.

The Chamber of Commerce, St. Paul, December 17, recognized the importance of commerce between St. Paul and Manitoba and the Red river country by appointing a standing committee to look after the extension of this commerce by aiding in securing the improvement of the Red river and in such other ways as should, from time to time, be deemed advisable.

CONTRACTORS.

The Brooklyn Bridge is progressing satisfactorily. The receipts to December 1 have been $3,060,949, and the expenditures, $7,979,889.03. Sixteen cable strands have been laid. There are 76 in all, 19 to each cable, and it is expected to complete the cables within a year. Work on the approaches is progressing rapidly. The contract for parapet stone has been awarded to the Concord Granite Company at $49,754.40. Bids for 325,000 lbs. of wire rope suspenders, either of Bessemer or crucible steel have been opened, and the contract awarded to Robeling's Sons at seven cents for Bessemer steel. A lengthy discussion took place in the board as to the relative merits of these steels, and Bessemer was decided to be sufficiently strong and cheaper, the lowest crucible bid being eight cents. The bids for cast iron rope sockets and for cable bands and bolts have been referred to the Board with power to make contracts. About 123 sockets of two sizes, one weighing 43 lbs., and the other 38 lbs. are required. The iron shall have a tensile strength of 40,000 lbs. 1,548 bands and bolts will be required, of which the greater portion are to be beveled to suit the inclination of the cable. Quality of iron, 50.000 tensile, and 20,000 without set. 48 cable bands made in parts for lateral connections will be required.

MUNCHAUSEN ENGINEERING.

"The world moves" is a saying so trite as almost to condemn the one who has the hardihood to repeat it. In these days of intellectual development, scientific discovery, and the invention of divers appliances which transport as on a fast freight line at express speed, the burden of modern civilization to an unknown terminus, this expression, born at the inception of intellectual freedom, and famous through the prosecution of a mediæval church, needs revision. A new term is wanted to denote our progress, and a new nomenclature in which to record it, lest, while we sit in the quiet of our sanctum—making out the time-table of the present and dreaming of the future, we be left in a hazy twilight as "the world moves" on into the mellow dawn of another day.

We had occasion previously to note three great schemes,—schemes which for magnificent expenditures, unparalleled labors, and the possible results to follow their execution, far transcend the fairy transformations of a Xmas tale. Let no one in future derisively say that a scientific training, or the practical study and routine of an engineer's experience blunts the perception and stunts the imagination.

These schemes are: the Canal du Midi, or the making of a through cut across France from the Bay of Biscay, *via* the valley of the Garonne, to the Gulf of Lyons on the Mediterranean, large enough for the free navigation of the largest ships; the making of a navigable strait between the Black and Caspian seas, through which the level of the Caspian is to be raised to that of the Black sea, an extensive area overflowed, and the climate of a large portion of Asia Minor, Persia and the deserts of Tartary ameliorated and the lands rendered fertile; and the overflow of a boundless basin in the great Sahara Desert, which is to bring trade and commerce to unknown nations, fertile showers to the barren half of a continent, and profoundly modify the climate of Europe.

Our mind has never been quite clear as to which of these three projects deserves the prize for magnificent, almost disdainful, disregard of the practical possibilities of this—we will not say—or any other generation, for that would be hampering the future. However, we are happy to inform our readers that all our doubts on the subject are now put at rest by a new and far bolder scheme, one that floats us above and away from the prosaic level of engineering journalism to the time when Cheops builded, the walls of Nineveh and Babylon grew, and the founders of empires were sired by the gods. The hem of the mantle of that age has lightly touched our own, or how else could a cold, barren, steppe-like country be transformed into a smiling fertile paradise and the frigid breezes turned into the wooing mellowness of a tropical zephyr. He who would do all this is indeed a god, or the day has passed forever by when the soul-lit fire of divinely-appointed genius is the "guide star" of the world, and halting plodding reason tags along in leading strings.

The sire of this last and greatest scheme, we know not. Let his name forever rest in oblivion, while those secret springs of the imagination, so happily described in "Hero Worship," erect him into a modern Woden or possibly old Sæter himself. The mid-wife and sponsor for the offspring is the Liverpool *Post*, and the St. Johns (N.B.) *Daily News* gladly assumes the duties of god-father.

The Arctic berg-bearing currents setting down the east coast of America *via* the Straits of Belle Isle and the St. Lawrence Gulf and over Newfoundland's banks, reduce the temperature of the whole coast region down to Hatteras far below that due to its latitude, producing, of course, a corresponding effect on the climate and products. Similarly, it is a common belief that the great but comparatively too famous Gulf Stream ameliorates directly or indirectly the climate of the whole of Western Europe, rendering it practically many degrees nearer the tropics than corresponding latitudes in America. We fear that this last belief will suffer through recent investigations.

"The scheme proposed" is to block the passage between Newfoundland and the Labrador coast, known as the Straits of Belle Isle. Through these straits "there constantly flowed into the Gulf a cold stream, and sometimes numerous icebergs from the Arctic seas, which had a chilling effect on the climate of surrounding regions, and which to a very large extent neutralized the influence of the portion of the Mexican Gulf stream which found its way into the St. Lawrence Gulf."

The Liverpool *Post* further declares that the scheme is pronounced quite practicable by eminent engineers, that the material for blocking the Straits is obtainable on the spot, and argues quite plausibly that the anticipated results would be sure to follow the shutting out of the frigid and berg-bearing Arctic current. It admits that the blocking would be a costly task, but contends that the result would amply justify the expenditure.

Ye gods, in solemn conclave assembled,—imagine for a moment the building of a mole across a strait, the breath of whose frigid, berg-bearing current blights half a continent! Is not the author of this scheme brother to that other god who, in a Bacchanalian mood proposed in the next foreign war to dam the Gulf stream by a mole across Florida's strait, and thus forever lay waste the "effete monarchies across the pond?"

No further competition will be allowed. We unhesitatingly rule out all such minor schemes as rectifying the Mississippi, a subsidized semi-monthly mail line to the moon *a la* Jules Verne, or the regeneration of the streets of Chicago. We award the prize to the scheme for closing the Straits of Belle Isle.

We timidly offer one suggestion. For fear that a miscalculation has been made as to the Gulf Stream's branching off into the St. Lawrence Gulf, we would include in the scheme a plan for a breakwater or training wall somewhere in the Atlantic to deflect it there, beyond peradventure. Then when the forbidding St. Lawrence shores have become a tropical dreamland, the home of aggressive capital and languid culture, the modern Phœnicia, and the seat of mighty empire, let a railroad be built from Newfoundland across the mole and up the shores of Labrador, along the route that Howgate shall locate to where the pole-star is always in the zenith, and all the less-noted luminaries circle about it, and in this summer resort let the merry belles and dames of the new Arcadia wile away the tedium of the long twilight in waltzing with the big and little bears around the pole.

As our paternal patrons go forth to buy the skates and sleds for the scions, let them not say there is too little material in engineering fields for a waggish, merry Xmas tale. The opportunity but waits the future Baron Munchausen.

ILLINOIS CANAL COMMISSIONERS' REPORT.

Mr. D. C. Jenne, Chief Engineer, submitted his report to the Canal Commissioners of Illinois on the 19th inst. The Copperas Creek lock and dam has been completed and in use since Oct. 23, making with Henry lock and dam 90 miles of completed seven-feet navigation. The total cost of the Copperas Creek dam and lock was $410,107.31, of which $347,747.51 was expended by the State and $62,357.80 by the United States. The original estimate made in 1870 was $427,493. The Spring Lake canal outlet above the dam cost $4,585.40. The engineer says that the complete improvement of the lower river will require three more locks and dams estimated to cost $1,350,000, one lock to be located at Beardstown, or a few miles below, one at or near Bedford, and the other about six miles above the mouth of the river.

If the funds were provided, the locks and dams could be built in three years. It would require, say, $350,000 the first year, $450,000 the second year, and $550,000 the last year, and the net revenues of the canal and locks on the river ought to produce $350,000 by the time this work is completed. This will leave $1,000,000 to be provided from other sources in the three years, which can all be repaid, with the interest, in five years after its completion, from the increased revenues of the canal and river.

Eight canal boats and a propeller, or tug, can pass the river lock, at one lockage, carrying 1800 to 2000 tons of freight. The distance from Chicago to St. Louis is 370 miles, and the freight rates when the improvement is complete, are estimated at ½ cent per ton per mile, or 9¼ cents per hundred,—5.55 cents for wheat and 5.18 for corn. About one-fourth of this would be for tolls. Lumber would be about $3.00 per M. The established rates for equal distances by rail are 11.91 cts. for wheat, 11.14 cts. for corn, and $6.25 for lumber.

Mr. Jenne reflects, very justly, we think, on the method of investigation by the Committee of the Assembly regarding damages from flowage.

Mr. Jenne also reports on the condition of the canal from Chicago to LaSalle, recommending repairs to the amount of $45,400 of which, however, only $15,100 will be required before next spring. The entire expenses for the canal during the year have been $110,018.44, of which $97,192.80 was for repairs ordinary and extraordinary.

There can be no doubt of the great importance of the Illinois river improvement to Chicago and the State at large. The whole improvement complete from La Salle to the mouth, 229 miles, will cost the State less than $10,000 per mile, and will pay for itself in tolls in five years after completion, and yet a legislature cannot be convened in Illinois wise enough to make the appropriation, while they spend twice that amount on a capitol building of doubtful architectural merit. When this improvement is complete, eleven lock and dams, constructed for the most part on rock foundations, and at comparatively small cost, will bring the slackwater system to Joliet, within eighty miles of Chicago. Then will Illinois boast the most complete and most remunerative water route on this continent, and one that will enable the large boats of the lower Mississippi to enter the harbor of Chicago and connect directly with the commerce of the Great Lakes. Yet the representatives of the Southern part of the State cannot see its utility because it does not run through their back yards. Following this improvement would be the Hennepin canal from near Henry to Rock Island, which can be constructed for a moderate sum, and would bring the boats of the upper Mississippi to our doors. These improvements would make Chicago's water system complete, and insure beyond peradventure her claims to be the metropolis of the great Northwest.

The same complaints that have been made for the past three years are again repeated in regard to the Ogden-Wentworth ditch nuisance. The damage to the property of the State from the silt brought from the Mud Lake region is estimated at $75,000, and the expenses for dredging and other repairs on that account the past year have been $16,475.94. Mr. Ogden, Chicago officials and Canal Commissioners all agree as to the cause of the trouble and yet no decided action has been taken to remedy the nuisance. True, the city during the summer has constructed a low dam across the head of the ditch, but the Canal Commissioners delare that it has not helped matters at all, and the first high water will destroy it. The effort is not confined to the canal. Every high water floods Bridgeport, fills up the slips and silts up the southwest branch of South Branch and also South Branch itself. The damage is large, and yet the city takes no positive action—at best, only half way measures. Of course there is a legal question involved as to the right to obstruct a flood channel. But a case might at least be brought before the court, and if the decision is adverse, legislative action might be sought. In the meantime a levee might be constructed, which would forever exclude the waters of the Des Plaines river. The city and State could far better afford to pay all the bills for damages, whatever they may be, than to allow it to remain as now. It is high time something is inaugurated if nothing more than a lawsuit.

It has been quite generally noted as a matter of moment in railway circles that the Chicago & Alton had at last concluded to extend their road from Mexico, Mo., into Kansas City, a distance of 162 miles. The Kansas City traffic of the Chicago & Alton has been and is conducted over the North Missouri railway from Mexico west. This traffic is said to be large and profitable and naturally the Chicago & Alton desire to control it and to reap the profits which they proposed to do by building the new line; and as naturally the North Missouri road desires to retain this traffic over its own lines. Hence, we are not suprised that conference committees have been appointed on the part of the two roads with the object of affecting some mutually profitable arrangement, and saving the additional investment on which patrons would ultimately be required to pay dividends. We understand that the North Missouri is pre-

pared to make the following proposition: Railway experts to be appointed to value their road-bed and property between Kansas City and Mexico, and to give the Chicago & Alton a perpetual lease for an annual rental of 3½ per cent. interest on the appraised value of the road. It would seem as if so favorable terms could hardly be rejected by the Chicago & Alton, and hence the construction of a new line appears quite doubtful. However, a final decision is not likely to be reached for some time yet.

INDIANA STATE-HOUSE.

The State-House Commissioners of Indiana have received the following instructions as to the nature of their report:

1. Can the building be completed according to the plans and specifications within the limit named in the law, namely, $2,000,000?
2. Are the foundations in character and extent sufficient to support the superstructure in such manner that no injury is to be apprehended to any point of the work from settling or crushing?
3. Are the materials of the superstructure in kind and quality such as to insure stability and permanence?
4. Are the combinations of materials such as to give strength and security to the entire structure, regard being had to the methods of spanning spaces between walls, constructions of roofs, dome and towers, supporting stairways, or other dependent portions?
5. Are dangers from fire sufficiently provided against?
6. Having regard to convenience, adaptability to the purposes required, harmony and dignity of the work, are the arrangements adequate for light to the corridors and rooms and offices, sunlight by day and gaslight by night? Is the building thoroughly ventilated?
7. Is ample provision made for safety, heating the building and all its parts, as also the needed supply of water easily and conveniently accessible?
9. Is drainage amply provided for?

Your opinion is also requested as to architectural symmetry, beauty and harmony of parts, including ornamentation and general conformity to the dignity, resources and progress of the State.

Contractor Martin is progressing favorably in the removal of the old capitol.

THE Secretary of War is reported as saying that he shall not make the next payment to Mr. Eads until a committee is sent down there to examine and report, the report of the inspecting officer not being deemed sufficient evidence.

A NEW railway journal called the *Railroader*, devoted specially to the interests of railway employés, will be started in Toledo, O., in January. It is to be a sixteen page monthly, edited by John McElroy, a gentleman connected with the Toledo daily papers for the past five years. Subscription price $1.00.

THE By-laws for a subvention of $300,000 to the proposed Toronto and Ottawa railway was defeated in Toronto on the 20th inst. by 1943 majority out of a total vote of 3,304. This majority is quite decisive, and it will probably influence Ottawa to reject her by-law also. The prospects for an early construction of the line is not bright. The Toronto *Mail* of the 21st inst, thinks the mistake will be corrected at a more opportune moment, and that the construction of the road is but a question of time.

A LIVELY and, in some cases, we are sorry to say, a not over-courteous, discussion is going on in gas-light circles as to the merits of "water gas," or the gas made by the Lowe process, which is now being put in operation in several cities and many others are taking steps towards its early introduction. In this connection the report of the committee of the Boston Board of Aldermen on the petition for its introduction into that city, which we print in this number, will be found of interest. We opine that the report of a board of aldermen, in which John Stuart Mill is liberally quoted, will be a real curiosity to all engineers outside of the "Hub." The aldermen of western cities are not likely to take to the practice very suddenly, if we may judge by the average specimen on file in Chicago.

ON the 18th inst., at Frankfort, Ky., a meeting of delegates from the various cities and counties interested in the improvement of the Kentucky river, was held. The improvement is estimated to cost in the neighborhood of a million dollars, and is to extend to the Three Forks near Beatyville, in Lee county. The five composite locks and dams have fallen into serious decay. The resolution contemplates an appropriation from the State to rebuild the five dams and locks of stone, said appropriation to be made this winter, that convict labor be employed, that the slackwater system be carried so far up the river as possible, and that the same system be applied to the other navigable rivers of the State as the means of the State will allow, that a Superintendent of Public Works be appointed, and that a committee be appointed to draft suitable bills for the legislature. Popular sentiment in Kentucky seems to favor a system of public improvements by the State, and as the State is at present out of debt, there is probabilty of favorable legislation this winter. The Kentucky river improvement, if carried up toward its source will do much to open up the mineral resources of Kentucky.

NOTES BY THE PUBLISHER.

The present number completes Vol. IV. of ENGINEERING NEWS. We beg leave to thank our patrons for past favors, and we solicit their continuance for the ensuing year, and for many years thereafter.

We will add four more pages to our journal next week, thus making it one of the largest class papers in the country. We will leave to its readers the privilege of judging as to the merits of its several departments after we have fairly completed our arrangements for the season.

Some time ago we notified our readers that they must apply at once for missing back numbers to complete volumes. Either very few numbers are missing, or not many care for complete volumes, as we have had to send off but a small number to supply the demand. We have therefore cleared our shelves of nearly all our back numbers, and even these will be disposed of within a few days. Most of what we have retained are made up into setts, incomplete of course, (as we have not a single complete Vol. IV. for sale) and will be sold at nominal prices to parties applying for them. There are possibly 25 such setts.

The next month is perhaps the busiest of the year with most of publishers; the majority of subscriptions are received with the commencement of the volume, and it is also a time when contemplated improvements on the papers is inaugurated by their proprietors. A great deal of labor and expense may be saved to the publisher by a prompt renewal of subscriptions, and we take this opportunity to ask this favor of the patrons of ENGINEERING NEWS, that they will not wait for a bill to be sent, but will remit amount due at once, thus saving to us the labor and expense of notifying each one of the expiration of his subscription.

Parties who wait till the end of the year to get a completed volume of ENGINEERING NEWS will be disappointed. Keeping "back numbers" does not pay for the shelf room and capital invested, and moreover it encourages wastefulness on the part of subscribers. We wish to enhance the value of past volumes of our journal and to encourage the careful preservation of each number as it is issued, and we beg leave at this time to assure our readers that the chances of replacing lost or mutilated numbers will be greatly lessened in the future. It will not be long until ENGINEERING NEWS will be the very best encylopœdia of engineering, and its value will be enhanced with its scarcity. We hope therefore we will be considered to have done our duty when we warn our readers against carelessness in preserving their copies.

The business of examining the correspondence of a newspaper, entering the amounts received, receipting for same, replying to innumerable questions, entering renewals and new subscriptions on subscription books and on printed list, and marking off expired ones, at the same time that the new conditions involved in a twenty five per cent. increase of labor in the preparation of the journal itself are to be met, cannot be done without making some blunders; the work has to be done by the regularly trained office force which is organized only for the regular work of the year, and we hope therefore our friends will overlook occasional mishaps, and notify us promptly of non-arrival of papers, the incorrectness of address, or any other matter which we can remedy. Many of our subscribers are frequently changing their places of abode, and do not notify us promptly of their changes; papers are lost and after a time they cannot be replaced, as we do not carry a stock of back numbers; this may be easily remedied as we are ready to do all we can possibly to accommodate our patrons.

WE take the liberty to publish the following extract from a private letter from Col. W. Milnor Roberts, Member of the Jetty Commission, referring to a valuable paper by him which will be published in ENGINEERING NEWS very shortly. We hope Col. Roberts will find time not far distant to favor the readers of ENGINEERING NEWS with some account of the labors of the Jetty Commission:

Editor ENGINEERING NEWS:

I enclose a much longer article than I intended to write: The difficulty with me is to write a *short* article on a subject in which I have a great store of facts; some of which can only consistently be brought to light in explanation of other published articles. The studies and discussions, both written and verbal, which took place in the Commission (six of whom were constantly together, day and night, for nearly five months), covered a wide field of investigation; scarcely any part of which has ever been given to the public. Our report, written by one of the officers of the army, was little more than the *results* arrived at. Minutes of regular meetings were kept; but these constitute but a very trifling portion of our real work; and I do not know that even those minutes were ever printed among the public documents.

I, probably, made more written memoranda and views than any other *one* member; and I did *promise* my fellow members (as they had requested me) that *when I had time*, (fortunate or unfortunate proviso), I would write out a little history of our European tour to the public works we examined; but it has not been done—not a line in that direction. Maps, plans, reports, etc., were to be gathered, *in Washington*—many of them sent from the foreign public works we had examined; and perhaps they *are* in Washington; where I have not been since our return, in 1874.

The public have very little idea of the labor and thought of that Commission that were brought to bear upon the subject of "Canal or Jetties" at the mouth of the Mississippi. Capt. Eads, only knows it in part.

Very truly yours,
W. M. Roberts.

CORRESPONDENCE.

[Special Correspondence ENGINEERING NEWS.]

CINCINNATI, OHIO, *Dec. 24th, 1877.*

"Very difficult work here for a civil engineer," was the uniform exclamation of European civil engineers who, in 1876, took short furloughs from the Centennial Exposition at Philadelphia, to pay flying visits to the great cities of the West. An ascent of the hills and a glance from their tops at their steep sloping sides, at the undulating semi-circular plain below, covered thickly with houses, and at the two great chasms cutting down through table lands from north to south, and serving as highways for the waters of Mill creek on the west, and of the now fabulous stream on the east, known for fifty years, after old mad Anthony Wayne built Fort Washington near its banks, as Deer Creek,—a glance at all this justified the exclamation.

Hills are bad enough—hills rising four hundred and seventy-five feet above low water mark in the Ohio river. In fact Cincinnati covers twenty-seven square miles of territory. Of this, seven miles will average about 120 feet above low water mark in the Ohio river, and twenty miles will average three hundred and fifty feet above the same standard. Low water in the Ohio is 432 feet above mean tide at Albany. Just think of draining Mount Auburn situated not quite three miles from the Ohio river on table land, bounded by steep escarpments, and averaging fully 425 above the river. It has not been tried yet, but the time is coming when something of the kind must be done. But Walnut Hills, Avondale, Woodburn, Corryville, Price's Hill, and half a dozen other little precincts stand as high and present as great difficulties as Mount Auburn. Then there is that everlasting sliding on the eastern faces of the hills. It is a singular fact that hills facing east here are most liable to slide, and that most hills facing south and southwest are stable as Gibralter.

But the engineer meets a difficulty worse than that presented by the wrinkled face of nature at this point,

He has an inheritance—an everlasting one—of trouble from his predecessors. In the first place there is the Gest standard—so named from an ancient engineer. The Gest standard is 1-1000 longer than the U. S. standard, which came into use after about five square miles of the city had been measured by the Gest rod. The U. S. standard rod was kept in the City Civil Engineer's office for years—in a little room heated up terribly in the winter by a stove. The poor thing kept shrinking, and the city engineers kept on making rods by it and using them. In the last seven years a platting commission has surveyed and platted nearly twenty miles of the city, laying out streets and establishing the lines of streets, using rods tested by this shrunken standard. This survey continued through several years. It is now known that rods compared with this standard in 1871-2 measure about five inches too little in 1000 feet. Here we have the Gest standard, the U. S. standard, and the shrunken standard, which evidently varied from time to time as it shrank. We are in a pickle.

As to benches for levels the case is not much better. The standard named in the ordinances is low water mark, as indicated by a monument at the pumping house of the water works, marked 62 feet above low water. But it has been discovered that this standard is about 32-100 of a foot short. Now the court house door sill is the standard that has been used from which to establish benches. It is recorded 120.62 feet above low water, which is correct. The point is that all ordinances establishing grades specify the false work at the water works as the standard, and that nearly if not all the city benches—which are door sills—have been established by comparison with the sill of the court house door. But these door sill benches are not reliable, some of them being nearly half a foot false on account of errors in establishing them.

Col. Merrill, U. S. Engineer in charge of the Ohio river improvement is surveying ground and making plans for a harbor in the mouth of Mill creek to protect steamers from damage by the breaking up of ice. Bids were opened to-day for operating a street railroad from the summit of Mt. Adams—head of an inclined plane—about two miles into Walnut Hills, and the lowest bid was: cash fare 4 cents; tickets in packages of 33 for one dollar. R.

"WATER GAS"

]From the Boston Transcript]

Report of a Committee of the Board of Aldermen of the city of Boston upon the petition of R. M. C. Graham and others to Establish the Manufacture of Water Gas in that city.

At a regular meeting of the Board of Aldermen, held on monday, Dec. 3, 1877, Alderman Thompson submitted the following;

The Committee on Lamps, to which was referred the accompanying petition of R. M. C. Graham and others, to lay gas mains and manufacture gas in the city of Boston, submit the following report:

Your committee have given such careful attention to the subject referred to them as the importance of the question demands. They have personally visited New York and the works of the Municipal Gas Company there, which is understood to manufacture its gas under a process and a patent like those proposed to be employed here. They do not profess to be experts in chemistry, or in the manipulations of the various materials used by different companies to produce gas of a good illuminative quality, but they have given to the various bearings of the subject such careful examination as enables them, in their opinion, to form an entelligent judgment on it.

There is no question that an article which at first was a luxury has now become almost a necessity in every household, and we hold it to be the duty of every municipal corporation to know that the gas distributed through the streets under its charge shall be of good quality, and sold at a price for public and private consumption which shall be fair and just.

It is fortunate that the merits of the whole case should have received so recently a full and exhaustive examination from the Gas Commissioners of the city of Boston, who spent more than a year and a half in the investigations from which they derived their conclusions; and it will be seen in the progress of this report how largely we are indebted to them for statements of facts, explanations of processes of manufacture, and the logical conclusions to which their examinations led.

As shown by their report there are substantially but three processes of gas making which have any considerable use. First—Coal gas, which furnishes the only illuminating gas for all the great cities of Europe, and of Boston and Philadelphia in this country; second, petroleum or naphtha gas, in partial use in some towns and cities in the United States; third, water gas, in moderate use in half a dozen different processes in this country.

Neither of these processes have been substantially improved since its invention, although each has been simplified, and advantageous changes in the details of manufacture have been made.

Full descriptions of the comparative values of each of these forms of manufacture are to be found on pages 9 to 33, inclusive, of the commissioners' report.

The petition now before us for consideration is for permission to introduce a form of water gas now in use in the city of New York.

Of the character of this gas it is sufficient to say that its use was forbidden in the city of Paris on account of the large amount of carbonic oxide which it contained, which a scientific commission of eminent chemists reported that it would be dangerous to introduce, even by way of experiment.

By a law which passed the New Jersey Legislature at its last session, no gas is allowed to be sold in the State which contains more than two per cent. of carbonic oxide. In explanation of this it may be stated that carbonic oxide is a gas of so poisonous a character that one volume of it diffused through one hundred volumes of air renders the latter unfit to sustain life.

It is said by the commissioner to be a pure physiological poison producing death almost as readily when diluted as when pure.

We here subjoin an analysis of the gas used by the Municipal Company by Prof. Henry Morton of the Stevens Institute of Technology, Hoboken New Jersey, a distinguished chemist, during the past summer,

Constituents.	Per cent. in volume.
Carbonic acid	.21
Oxygen	.14
Olefiant gas and like "illuminants"	15.12
Benzine vapors and like "illuminants"	1.13
Carbonic oxide	26.18
Hydrogen	27.29
Marsh gas	25.54
Nitrogen	4.45
	99.96

The amount of carbonic oxide here shown, viz., about twenty-six per cent., is in my opinion, quite enough to render this gas very dangerous in view of the liability to leakage and escape which exists in its destribution and use. The amount of carbonic acid which this gas will develope in burning will also be about 50 per cent. more than that produced by ordinary coal gas.

Carbonic acid, as is well known, is fatal to life immediately if present to the extent of thirty per cent. in the air inhaled, and produces serious injury if present to the extent of even one or two per cent. in air which is inhaled for a long time.

"Carbonic oxide is, however, far more poisonous, and is stated to produce fatal effects when present even to the extent of three per cent. in the air inhaled; even very minute quantities producing severe symptoms of headaches, giddiness, etc., in a short time."

Before considering especially in detail what the petitioners desire, it is obvious that the establishment of such a manufacture must bring into employment additional capital upon which the gas consumers must pay interest. It is worth while to look for a moment at the price of gas as affected by the capital employed to manufacture and distribute it.

There is invested in the city of New York in gas capital and bonds the sum of $20,750,000, or $20.75 to each inhabitant on the basis of 1,000,000 population.

With recent proposed additions, Brooklyn will have invested a capital of $11,845,000, or $23.69t o each inhabitant, estimating the population at half a million.

In the large district supplied by the Boston companies, $5,333.000 is invested, or $15.24 to each inhabitant, on the basis of 350,000 population.

The practical result from this is that gas is sold to private consumers by every company but one in New York and Brooklyn at $2.50 per 1,000 cubic feet, while in Boston proper it has been for many years sold at a lower price than in either of those cities, and the price is now $1.25 per 1,000 cubic feet.

The general reasons for this result may be found in the masterly statement of John Stuart Mill, quoted in the hearing before the Board of Aldermen in 1874, page 124, and in the Commissioners' report, pages 60 and 61.

"When in any employment, the regime of independent small producers has either never been possible, or has been suspended, and the system of many work people under one management has become fully established, from that time any further enlargement in the scale of production is generally an unqualified benefit. It is obvious, for example, how great an economy of labor would be obtained if London were to be supplied with a single gas or water company, instead of the existing plurality. While there are even as many as two, this implies doubtful establishments of all sorts, when one only, with a small increase, could probably perform the whole operation equally well; double sets of machinery and works, when the whole of the gas or water required could generally be produced by one set only; even double sets of pipes, if the companies did not prevent this needless expense, by agreeing upon a division of the territory. Were there only one establishment, it could make lower charges consistently with obtaining the rate of profit now realized. It is, however, an error to suppose that prices are even permently kept down by the competition of these companies. Where competitors are so few, they always end by agreeing not to compete. They may run a race of cheapness to ruin a new candidate, but as soon as he has established his footing they come to terms with him. When, therefore, a business of real public importance can only be carried on advantageously upon so large a scale as to render the liberty of competition almost illusory it is an unthrifty dispensation of the public resources, that several costly sets of arrangements should be kept up for the purpose of rendering to the community this one service. It is much better to treat it at once as a public function; and if it be not such as the government itself could beneficially undertake, it should be made over entire to the company or association, which will perform it on the best terms for the public. In the case of railways, for example, no one can desire to see the enormous waste of capital and land (not to speak of increased nuisance) involved in the construction of a second railway to connect the same places already united by an existing one, while the two would not do the work better than it could be done by one, and after a short time would probably be amalgamated. Only one such line ought to be permitted; but the control over that line never ought to be parted with by the State, unless on a temporary concession as in France; and the vested right which Parliament has allowed to be acquired by the existing companies, like all other proprietary rights which are opposed to public utility, is morally valid only as a claim to compensation."

In this connection we quote to the same point from the commissioners' report, p. 61 as follows:

"In the early days of railroads in this country and England competition was regarded as the sovereign remedy for high rates of transportation; but the result has shown that to be a vast waste of capital, and compelled the public to pay interest on the cost of many lines which should never have been built. In gas companies the result has been the same, wherever competition in the same district has been carried to its legitimate and necessary issue. But one line of main pipes was necessary to supply the public wants, and wherever two were laid, in some form or other, the consumer must pay the cost of the unnecessary expenditure. Such a competition has led to precisely the result which might have been expected, a combination of, or compromise between, the companies, and an increased rate of gas to the consumers to pay the interest on the unnecessary waste of capital.

"While the public interest in the proper and economical management of gas companies is less in extent than that in the management of railroad corporations, it is precisely of the same nature. Both are and must remain monopolies. Both are liable to be conducted arbitrarily and in a manner to injure and abuse. The railroad corporations of this State have been always controlled by law, while the gas companies have been left to pursue their way unchecked and untrammelled; and it is due to their managers to say that, in most instances they have not abused the license they have enjoyed."

The advantages which the petitioners offer are two—a nominally lower price for the gas for the street lamps, including the care of the lamps; and a lower price for the gas used in the public buildings; with respect to the price to be charged to private consumers nothing is said in their proposals.

As regards the street lamps, they propose to use

three-feet burners as is done in New York, where the lamps are placed 100 feet apart.

In Boston, burners consuming not less than four feet per hour are used, and the lamps are 150 feet apart,

It will be seen, therefore, that to cover the same space which is now lighted by two lamps there must be by the new plan three lamps, the cost of which will be $75 per annum.

The experience of the lamp department shows that this is a little more than it now costs in the city proper.

As regards the public buildings the quantity of gas used is so small as not to be worth considering.

Whatever saving there might be would be far more than offset by the injury to the streets and the inconvenience to the public.

The whole cost of gas for the public buildings, for the year ending May 1, 1877, was $39,200.28. Of this sum $24,378.62 was paid to the Boston gas-light company, for the gas furnished to the buildings in the city proper.

At the price at which the petitioners propose to furnish gas the cost would have been but $1500 less; and this saving is all the advantage which the city would derive from the grant of a perpetual right to a new corporation to break up the pavements and interrupt public travel whenever the necessities or convenience of the new corporation might require.

These are the considerations which are offered the city of Boston as reasons for the investment of further capital in the business, for the injury to be done to the streets, and for the erection of works, of the dangerous character of all works where naphtha is used.

In this connection we may quote advantageously some of the conclusions of the gas commissioners.

"I. That the citizens of Boston are being supplied by the Boston gas-light company with gas of excellent quality and at a price, in comparison with the cost of coal and the quality of the gas, lower than in most of the cities in the United States. No fair comparison can be made in regard to price with European cities, on account of the great difference in the cost of labor and material, and the value of residuals.

"II. That there are other processes than those in use in the various companies in this city by which illuminating gas can be made, and for which great improvements in regard to cost and quality are claimed. At this present time, however, it would probably be impossible for a large gas company like the Boston gas-light company, to make use of any process for the manufacture of illuminating gas from naphtha or petroleum, without either paying a considerable royalty or becoming involved in a lawsuit for the alleged infringement of some patent. It is, nevertheless, doubtful whether any of the patents for using petroleum or naphtha in gas-making are valid. We advise most decidedly against the admission of another private gas corporation within the limits of Boston to compete in the sale of gas with the existing companies, as being disadvantageous to the public generally."

In the course of our investigations we have visited the gas works in this city and the largest gas works in New York, as well as the Municipal gas company works, and we find the works of the Boston gas-light company fully up to the standard of the best works which have been visited; and we believe that it is admitted by all gas engineers that their apparatus for experimental purposes is not surpassed by any in the country.

Your committee are of the opinion that it is not for the interest of the city to grant permission to another company to dig up its streets in order to try the experiment whether cheaper or better gas can be made from some other material than coal.

It is for the interest of every gas company to make its gas as cheaply as possible; and all experiments for this purpose may be safely left to the companies already established.

If the experiment succeeds, the new process of the new material is sure to be adopted by the watchful and intelligent managers of gas companies.

If it fails, no great harm has been done. But if new works have been built and new mains have been laid in the streets to try an experiment which proves to be unsuccessful, the community is at once subjected to a heavy loss in addition to the inconvenience and ultimate loss which have been found to follow invariably from the acts of compelling gas companies; no one has been benefitted except the contractor for building the works.

Your committee, for the reasons herein set forth recommend that the petitioners be granted leave to withdraw.

FRANCIS THOMPSON,
GEO. DUNBAR,
R. W. ROBINSON.
Committee on Lamps.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER-WORKS.

An opposition company proposes to bring water into Oakland, Cal.

The artesian well at Linwood, Iowa, is 800 feet deep. Water is expected at 1200 to 1300 feet.

Bernhart Reservoir, one of the sources of Reading's water supply, has just been cleansed. The reservoir, which covers about seven acres of ground, was found to be in filthy condition. About eight thousand cart loads of mud were removed.

Articles of association of the Citizens' Gas Company of Jeffersonville, Ind., were filed in the office of the Secretary of State on the 19th inst. The capital stock is $25,000. The company propose to carry on its business in the towns of Port Fulton Clarksville and Ohio Falls, as well as in the city of Jeffersonville.

The agitation in Council Bluffs, Iowa, is assuming an active form. Some of the citizens charge members of the city council with unseemly haste to let the contract to Mr. Wiley, the representative of the Boston company which desires to build the works. As the agitating is getting to be quite general, definite action some kind will probably soon be taken.

RAILROADS.

A railroad has lately been chartered from Wheeling to Ceredo, down the Ohio River,

A narrow guage railway is proposed from Salamanca, N. Y. to Bradford, Pa., 15 miles.

A railway of 2 feet guage is projected from Brattleboro, Vt., up the valley of West river.

An exchange says the Pennsylvania railroad company are surveying a route from Wilkes-Barre to Northumberland.

The necessary steps to secure the railway from East Saginaw to Vasser have been taken by the citizens of East Saginaw.

A railway is proposed up the Umatilla Valley from the Columbia river via Meadowville and Pendleton to Weston, Oregon.

The proposed route of the extension to be made by the Kentucky Central railroad from Lexington to Richmond has been surveyed.

The by-law for $200,000 debenture to the Toronto & Ottawa railway, owing to its defeat in Toronto has been withdrawn in Ottawa.

The cost of a first class railway passenger car as constructed by the Pennsylvania Central Co., at the shops at Altoona, Pa., as $4,423.75.

The grading on the Canadian Pacific is nearly completed to Savanne, 72 miles from Ft. William. The track is ballasted to Kaministiquia Crossing.

The citizens of Berrien Springs, Mich., are endeavoring to secure the completion to that place of the Cincinnati. Warsaw & Michigan railway.

A company has been organized to build a railway from Fairfield, Texas, to Oakwood on the International & Great Northern, a distance of 22 miles.

The survey of the Chicago, Quincy & Western is completed from Quincy to Mason City, Ill., about 90 miles. It is said that grading will soon commence.

There is a movement afoot to construct a railway from tide-water at Napa to Clear Lake, Lake Co., Cal., the people of the two counties to furnish the capital.

Cincinnati is considering the location of the depot for the Southern railway. An up-town site is advocated and would necessitate a $50,000 approach to the bridge.

Work is progressing on the East and West railroad at Robinson, Illinois, as well as at several other points on the line of the road between Palestine and Oblong.

A narrow guage railway is proposed from San Buenaventura, Cal., up the Santa Clara Valley to Newhall Station on the Southern Pacific railway. The Santa Clara Valley is one of the richest of California.

The Bismark, Fort Lincoln and Black Hills (narrow guage) Railway Company has been incorporated to build a railway from Bismark to the Black Hills. The route is now under examination.

Belief in the existance of a subterranean lake, near Newburyport, Mass., led to the sinking of a well. Clear water was found, at a depth of fifty feet, in such quantities that there is talk of supplying the city with it.

A new company has been formed under the title of the Saugeen Valley Railroad Company to build a line from Mount Forest to Walkerton, to connect at the former place with the Toronto, Grey and Bruce railway.

Work is being vigorously prosecuted on the South Pacific (narrow guage) Railroad, and it is represented that the line will be in working order from Alameda to Santa Cruz by the end of May. The construction of this railroad is an enterprise of considerable magnitude. It involves the piercing of the Santa Cruz mountains with a tunnel one and one quarter miles in length, the contract price of which foots up $480,000.

Boston parties are going to make a survey from West Brookfield to Belchertown for a new route to the Hoosac Tunnel. This link with a road from Belchertown to the nearest point on the Hoosac Tunnel line, would reduce the distance from Schenectady, N. Y., to Boston 28 miles. From West Brookfield to Belchertown it is but 14 miles by the shortest route, and with no grades of more than thirty feet to the mile.

MISCELLANEOUS.

Steps are being taken to establish a school of Technology at Halifax.

Sangamon county, Illinois, is about to erect a new jail at a cost of $50,000.

The new locks at the Saut Ste. Marie ship canal will take two years yet to completion.

The Cleveland and Pittsburgh Railroad bridge at Mingo Junction, Ohio, burned on the 23d inst.

The cost of cleaning the sewers and sewer basins of Brooklyn the present year, will amount to $34,000.

St. Louis is moving in the matter of direct trade with South America and the West Indies via New Orleans.

The Sutro tunnel has now been pushed to within 1800 feet of the Comstock lode. and will be finished in a few months.

The engineer of Indianapolis estimates the cost of a 3½ ft. sewer for draining the State house grounds at $5,168.40.

New York's street cleaning costs $1,500,000 per annum, and yet there is just complaint of the filthiness of her streets and by-ways.

The Chicago and Northwestern Railway company is to shortly commence the building of a new bridge across the Fox River at Oshkosh.

An expedition under the auspices of the French government is to be sent to San Francisco to observe the transit of Mercury which occurs on May 6, 1878.

An investigation in the management of Prospect Park Brooklyn, by the commission, showed that $6100 was charged to expenses of a mythical engineer corps.

The citizens of St. Joseph, Mich., are dredging a channel from the south branch of the river to the main stream. The money is raised by voluntary subscription

Ex-Gov. McCormick, the American commissioner general to the Paris exhibition, will open his office in New York, Monday in the post office building. Many applications for space have already been received.

A proposition is before the Richmond city council that, on account of the recent damage to the James river at Kanawha canal, necessitating expensive repairs, the canal be abandoned as a canal and the works used as the road-bed of a railway.

Gov. Crapswell, of Michigan in a recent letter, favors a canal across Michigan but states that as the constitution of the State prohibits the undertaking of public improvements of this character, it will have to be undertaken by the general government.

The estimated cost of the contemplated bridge to connect the Montreal and Ottawa Railway with Ottawa, above Chaudiere Falls, is $610,500. The estimated cost of the proposed bridge at New Edinburgh is $300,000, including the grading of approaches to the Union depot.

The 39th Annual Report of the Board of Public Works, of Ohio, is in the hands of the Governor. It is mainly taken up with a description of the canals and the troubles between the Board and the lessees. The receipts of the Board from all sources has been $5,042.56, and the expenditures $20,254.97.

The Pennsylvania Railroad Company has just completed the building of a new iron bridge over the Susquehanna river at Rockville, above Harrisburg. The wooden spans were removed one by one as the iron ones were built. The new bridge is double track composed of 23 spans the total length being 3,686 feet, cost $400,000.